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# Washability Characteristics of Arkansas and Texas Lignites: Report of Investigations

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Prepared for

Industrial Environmental Research Lab.
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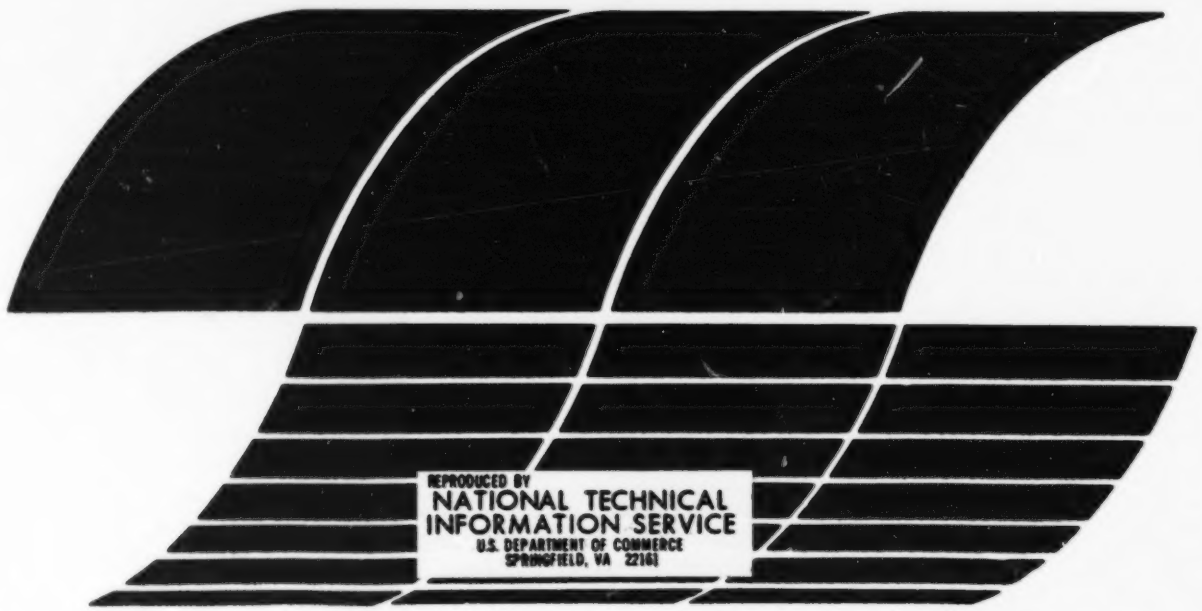
| U.S. Environmental Protection Agency | Industrial Environmental Research Laboratory<br>Research Triangle Park NC 27711 | EPA-600/7-79-149<br>June 1979 |


# Washability Characteristics of Arkansas and Texas Lignites:
## Report of Investigations

## Interagency Energy/Environment R&D Program Report



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# WASHABILITY CHARACTERISTICS OF ARKANSAS AND TEXAS LIGNITES

by

J. A. Cavallaro[1] and A. F. Baker[2]

## ABSTRACT

This report describes the washability characteristics of eleven channel samples of lignite, four from Arkansas and seven from Texas.

Only two of the samples, those collected from Dallas County, Arkansas, could be upgraded to meet the current EPA new source performance standard (NSPS) of 1.2 pounds $SO_2$/MM Btu. The other nine samples, although averaging only a little over 1 percent total sulfur, were relatively high in organic sulfur considering their low Btu/lb value, and could not be upgraded to meet the standard.

Physical coal cleaning of these samples, however, provided significant ash reduction which may reduce boiler fouling.

It was demonstrated that much of the sodium can be removed from these Arkansas and Texas lignites by ion exchange. Analyses showed 37 to 91 percent sodium oxide reduction after treatment with a solution containing calcium ions.

## INTRODUCTION

In 1977 the electric utilities burned 477 million tons of coal with an average sulfur content of 2.0 percent. The amount of coal consumed by electric utilities is anticipated to reach 525 million tons by 1980 and approximately a billion tons by the year 2000 (7). Because coal-fired electric utility plants are the major source of sulfur oxide air pollution in the United States today, EPA and its counterparts have placed major emphasis on developing methods for controlling these emissions.

Since 1965, the Environmental Protection Agency (or its predecessor The National Air Pollution Control Administration) has funded a study by

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[1]Supervisory Chemical Engineer.
[2]Supervisory Physicist.

the Coal Preparation Division of the U.S. Department of Energy (DOE), formerly the U.S. Bureau of Mines, Department of the Interior, to determine the amount of the various forms of sulfur in major sources of utility steam coals and the washabilities of these coals. The EPA new source performance standard is 1.2 pounds $SO_2$/MM Btu. This means that a coal containing 13,000 Btu/lb can contain only 0.8 percent sulfur in order to meet the standard. However, a lignite averaging 10,000 Btu/lb (moisture free) could only contain 0.6 percent sulfur in order to meet the standard.

Because of our need for increasing coal utilization to meet rapidly growing energy needs, the DOE is expanding its investigation of the preparation characteristics of United States coals to include various low rank coals and lignite.

To date, very little information has been published on the removal of impurities from lignite by coal preparation. The purpose of the present study was to determine the potential of upgrading selected Arkansas and Texas lignites by coal preparation techniques to improve their utilization in combustion and conversion processes.

Physical cleaning can reduce the sulfur in coal which occurs as pyrite, but it leaves the organic sulfur in the clean coal. For some coals, however, coal cleaning may eliminate or minimize the need for stack-gas scrubbing for achieving air quality criteria. Hence, coal washing techniques that remove pyritic sulfur and other impurities cheaply and efficiently can be used as a primary upgrading step before utilization.

The deposition of ash on the heat transfer surfaces in boilers is a problem in lignite combustion. This problem is aggravated by the mineral constituents present in lignite. Sodium, an alkaline metal, has been found to be the element chiefly responsible for accelerating the fouling of boiler tubes (12). At high sodium levels, frequent cleaning of the boilers is often necessary to maintain steam production. Tests have shown, however, that the sodium content of lignite can be reduced by an ion exchange process (8). It has also been found that the rate of boiler fouling depends upon the quantity of ash present in lignite. Tufte et al. (12) have shown that the ash fouling rate of boiler tubes increases exponentially with the ash content regardless of the sodium oxide content of the ash.

This report describes the results from washability tests to determine the ash and sulfur reduction potential of selected Arkansas and Texas lignites by stage crushing and subsequent specific gravity separation. Supplementary data are presented to show the effect of treating these lignites by an ion exchange process to reduce their sodium content. Data are also presented to characterize the chemical and physical properties of the lignite samples collected in this investigation.

ACKNOWLEDGMENTS

The authors wish to acknowledge the cooperation and help of those engineers, geologists, and mining company officials contacted during this investigation. The assistance of R. B. Stroud, U.S. Bureau of Mines State Liaison Officer, Arkansas, and M. E. Hawkins, U.S. Bureau of Mines State Liaison Officer, Texas, is gratefully acknowledged. The authors also wish to thank R. A. Welsh, U.S. Department of Energy for collecting the samples and W. Dickie, C. Grimes, and U. Weinheimer, U.S. Department of Energy, for performing the washability analyses on the various coal samples.

The work was funded by the Environmental Protection Agency, and the authors wish to acknowledge the assistance of T. Kelly Janes, James Kilgroe, and David A. Kirchgessner from the Industrial Environmental Research Laboratory of the Environmental Protection Agency, Research Triangle Park, N.C.

## TEST PROCEDURE

### Collection of Samples

Face samples were collected from surface mines in Arkansas (four samples) and Texas (seven samples). The mines which were active were producing coal primarily for consumption by electric utilities. The four channel samples from Arkansas ranged from 2 feet 7 inches to 3 feet 1 inch thick; the seven samples from Texas ranged from 5 feet 4 inches to 12 feet thick. Four of the Texas mines sampled produce coal for electric power generation, one produces coal for making activated carbon, and two are prospect mines. Identification of the coal samples collected is presented in table 1.

TABLE 1. - Identification of coal samples collected

| Sample No. | State | County | Group |
|---|---|---|---|
| 1 | Arkansas | Dallas | Wilcox (top bench) |
| 2 | " | " | Wilcox (bottom bench) |
| 3 | " | Ouachita | " |
| 4 | " | Saline | " |
| 5 | Texas | Freestone | " |
| 6 | " | " | " |
| 7 | " | Harrison | " |
| 8 | " | Milam | " |
| 9 | " | Panola | " |
| 10 | " | Titus | " |
| 11 | " | Angelina | Claiborne |

Face samples were collected according to the procedure recommended by Fieldner and Selvig (2) and Holmes (5), except that the dimensions of each sample cut were expanded to permit 600 pounds of coal to be taken from the face. Partings and impurities were not removed from the samples unless otherwise noted. The face was cleared of loose coal or dirt for a width of approximately 5 feet. Loose pieces of roof were also taken down to prevent them from falling into the sample while it was being collected. Within the cleaned area of the face, the coal was cut from the roof to the floor in a channel 1 inch deep and about 3 feet wide to remove any altered or otherwise inferior coal such as oxidized coal. The floor was then cleared and smoothed, and a sampling cloth was spread to catch the sample.

The channel sample was cut perpendicular to the lay of the coalbed, approximately 10 inches deep, and wide enough to provide a sample of 600 pounds. For example, for a 4-foot-thick coalbed a channel 30.5 inches wide would be collected. The procedure is modified when a strip mine sample is obtained where the overburden has been removed. In this case, the depth and width of the channel would be equal. For example, for the 4-foot-thick bed noted above, the channel would be 17.5 inches deep by 17.5 inches wide. The collected sample includes all partings and other impurities occurring in the channel.

## Sample Preparation

The 600-pound channel samples collected in the field were loaded into steel drums containing plastic liners and returned to the coal preparation laboratory for processing. The sample preparation procedure is outlined in the flowsheet shown in figure 1. Each sample to be tested was air dried and crushed to 1-1/2-inch top size using a roll crusher. The sample was then coned, long piled, and shoveled into four pans, according to ASTM specifications, and divided into two portions by combining opposite pans. Each sample was divided into two coarse portions. One portion was crushed to 1-1/2 inches top size and sized 1-1/2 inches by 3/8 inch, 3/8 inch by 14 mesh, 14 by 100 mesh, and minus 100 mesh. The other portion was crushed to 3/8 inch top size and sized 3/8 inch by 14 mesh, 14 by 100 mesh, and minus 100 mesh. The cumulative percentage of material retained on each screen was plotted on Rosin and Rammler paper (9), and the size distribution coefficient $n$ was determined from the slope of the line representing the data. The size distribution constant $n$ is a measure of the degree of dispersion of particle size. The percentage of fines in a coal tend to increase with decreasing values of $n$. The minus 100 mesh material was removed from each portion and analyzed for chemical and physical properties.

Each of the remaining portions was float-sink tested at 1.30, 1.40, and 1.60 specific gravities using CERTIGRAV,[3] a commercial organic

[3]Reference to specific brands does not imply endorsement by the Department of Energy.

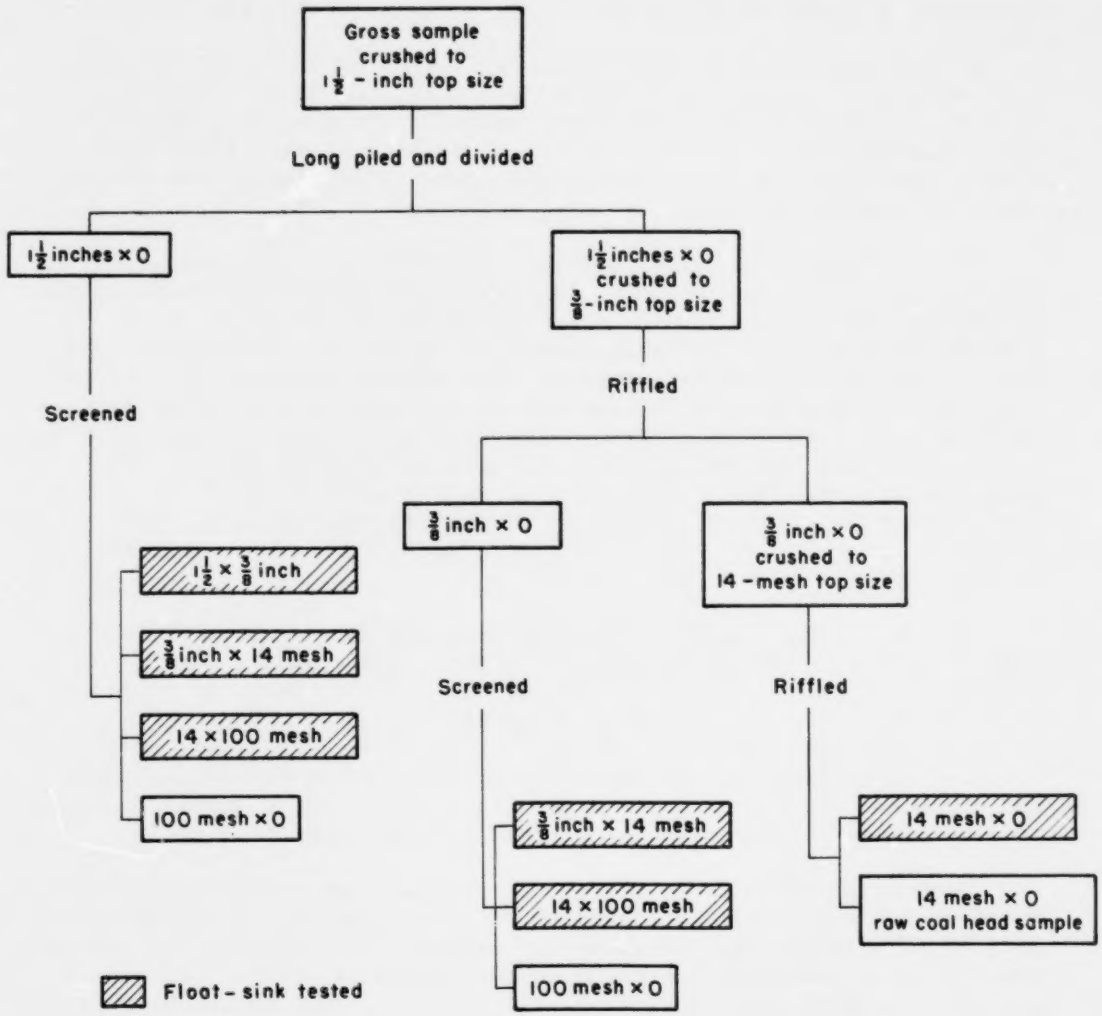
Gross sample crushed to 1½ - inch top size
Long piled and divided
1½ inches × 0
1½ inches × 0 crushed to ⅜-inch top size
Screened
Riffled
⅜ inch × 0
⅜ inch × 0 crushed to 14 - mesh top size
1½ × ⅜ inch
⅜ inch × 14 mesh
14 × 100 mesh
100 mesh × 0
Screened
Riffled
⅜ inch × 14 mesh
14 × 100 mesh
100 mesh × 0
14 mesh × 0
14 mesh × 0 raw coal head sample
Float - sink tested

FIGURE 1. - Flow diagram showing preparation of face samples.

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liquid of standardized specific gravity produced by American Minechem Corporation; the solution tolerance was ±0.001 specific gravity unit and was monitored using a spindle hydrometer. A third portion crushed to 14 mesh top size was float-sink tested in its entirety at the same specific gravities. Analyses of sodium oxide in the ash were obtained on each of the specific gravity fractions of the sample crushed to 14 mesh top size. However, the sodium oxide in the ash was recalculated and is presented on a coal basis in the tables showing washability results.

A head sample was riffled from the 14-mesh by 0 portion for proximate analysis (moisture, ash, volatile matter, and fixed carbon), ultimate analysis (carbon, hydrogen, sulfur, nitrogen, ash, and oxygen) and determination of calorific value, fusibility of ash, major elements in ash, free-swelling index, Hardgrove grindability index, and sulfur forms and content (pyritic, organic, and total).

For the two coarse sized samples, the separation was made in a screen bottom container which is inserted in 10-gallon-capacity vessels containing the organic liquid. The sample was placed in the 1.30 specific gravity bath, in small quantities to prevent entrapment, and was stirred and allowed to separate. The lighter specific gravity coal fraction was removed from the surface of the bath with a screen wire strainer; the heavier specific gravity material settled to the container bottom which was then raised above the liquid level to drain. The container with the heavier specific gravity material was placed in the 1.40 specific gravity solution and the process was repeated. This procedure was continued until the sample was separated into the desired specific gravity fractions.

For the 14-mesh by 0 size sample, the separation was made in glass separatory flasks joined by standard ground taper joints. After the sample separated, a stopper was passed through the float layer and inserted into the neck of the upper section of the separatory flask. The flask was then separated and both products were filtered. The "floats" were dried and prepared for analysis, while the "sinks" were reintroduced into another separatory flask containing a heavier specific gravity liquid and the float-sink procedure was repeated.

Upon completion of the float-sink testing, the specific gravity fractions of the three sized samples were analyzed for calorific value, ash, pyritic sulfur, and total sulfur content. All product analyses are reported on a moisture-free basis unless otherwise noted. Raw coal moisture, as presented in the appendix tables, is the moisture contained in the sample after it was air dried at the coal preparation laboratory. The air dry loss is not included in the moisture determination. It is felt that under normal conditions the moisture content as reported here would closely simulate the moisture content of the coal burned at the powerplant.

Specific gravity separations of fine coal are particularly difficult, especially with coals that are porous and contain high inherent moisture contents, because the heavy liquid used can penetrate the pores displacing the capillary held water, thus causing an increase in the apparent specific gravity of the coal. This may explain the unexpectedly low weight recoveries with some of the minus 14 mesh size fractions at specific gravity 1.30.

The float-sink data from the channel samples do not necessarily represent the quality of the product loaded at the mine where the sample was taken but rather indicate the quality of the bed in that particular geographical location. Float-sink data are based upon theoretically perfect specific gravity separations that are approached but not equaled in commercial practice.

To supplement the washability study, tests were carried out to demonstrate the sodium reduction potential of the lignite samples by ion exchange. In these empirical type tests, the sample was stirred for 5 minutes in a vessel with a solution containing the equivalent of 10 pounds of calcium chloride ($CaCl_2$) per ton of dry lignite. All tests were performed at room temperature with the minus 14 mesh head samples and float 1.60 specific gravity fractions. After treatment, the products were analyzed for the $Na_2O$ content of the ash.

## ARKANSAS LIGNITES

### Geology

Lignite is known to occur in beds primarily of Tertiary age in a broad zone that extends from southwestern to northeastern Arkansas (figure 2).

Rocks containing lignite are exposed in an area of about 6,125 square miles in the Gulf Coastal Plain of Arkansas. From oldest to youngest, these rocks are the Tokio group of Cretaceous age, and the Wilcox group, Claiborne group, and Jackson group of Eocene age. Beds of lignite are more abundant and generally thicker in the Wilcox group. These rocks contain numerous beds of lignite ranging from a fraction of a foot to more than 22 feet thick. The geology of the Arkansas lignite has been described by Haley (4).

Figure 3 is a generalized cross section of Paleocene and Eocene groups of formations of lignite in the southern part of Arkansas (3).

### Reserves

The estimate of the lignite reserves in Arkansas was prepared on a basis of original reserves of lignite before mining (table 2). The

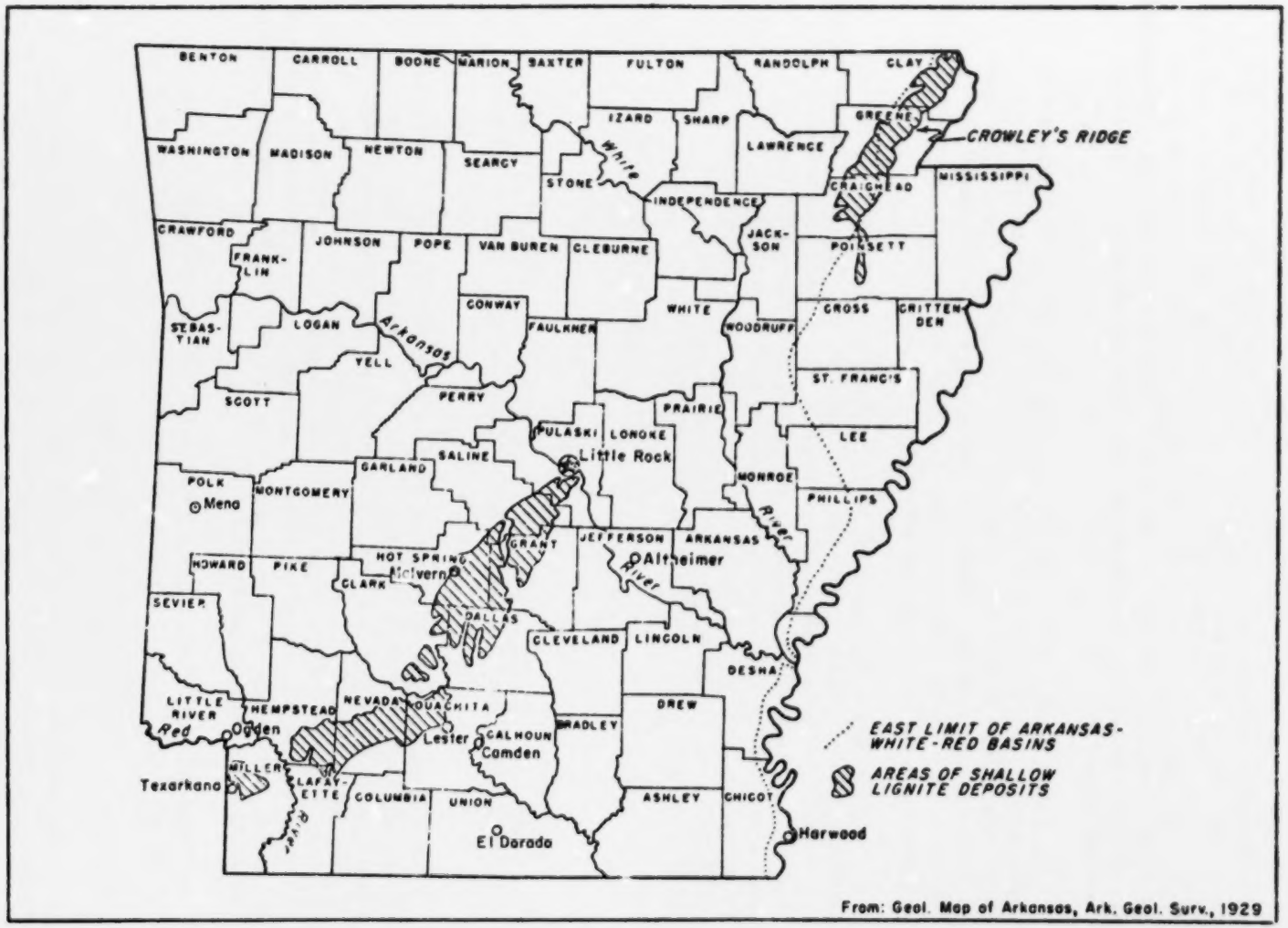


FIGURE 2. - Areas of shallow, lignite deposits in Arkansas.

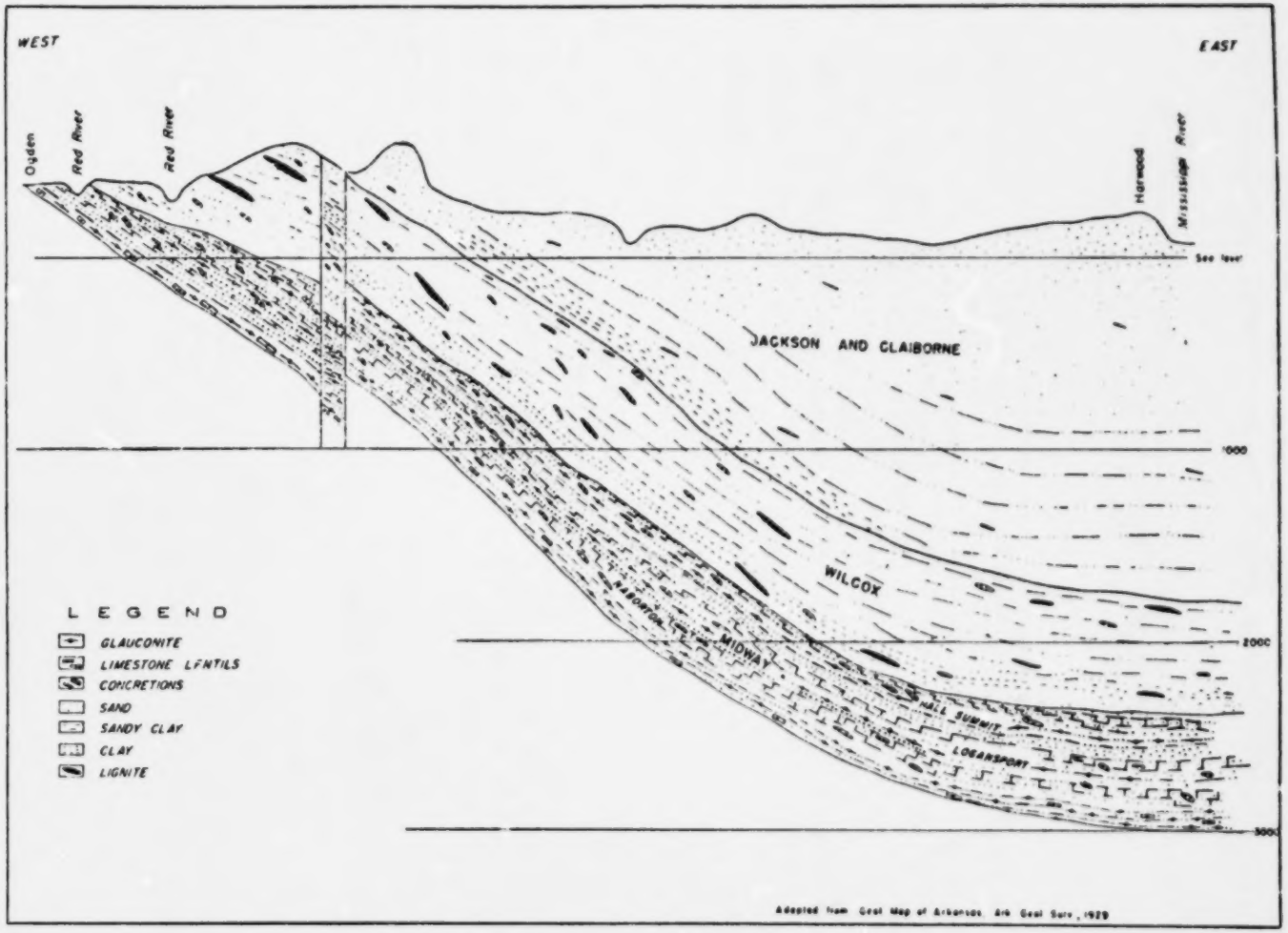


FIGURE 3. - Generalized cross section.

(Indicated lignite occurrences are not drawn to scale nor are they specifically located)

original reserves of lignite in known deposits are estimated to be 32 million short tons (11). This estimated total pertains to known deposits of lignite thicker than 30 inches and under less than 100 feet of overburden.

TABLE 2. - Estimated original reserves of Arkansas lignite in deposits more than 30 inches thick and lying beneath less than 100 feet of overburden

(In thousands of short tons)

| County | Total | County | Total |
|---|---|---|---|
| Ashley | (1) | Greene | 200 |
| Bradley | 300 | Hot Spring | 300 |
| Calhoun | 200 | Nevada | 400 |
| Clark | 300 | Ouachita | 5,200 |
| Clay | (1) | Poinsett | 700 |
| Cleveland | 200 | Pulaski | 12,500 |
| Craighead | (1) | Saline | 6,500 |
| Cross | (1) | | |
| Dallas | 4,900 | Total | 32,000 |
| Grant | 300 | | |

[1]Incomplete thickness data, or lignite less than 30 inch thick.

Lignite under more than 100 feet of overburden has been found in cores from core drilling and in rock cuttings from wells drilled for oil throughout much of the Gulf Coastal Plain. The total reserves of lignite in Arkansas are tentatively estimated to be 350 million short tons. A more accurate estimate of the lignite reserves in Arkansas would be dependent upon data obtained by an intensive mapping and core-drilling program. Arkansas lignites have the following ranges of composition by proximate analyses: Moisture--23.4 to 52.4 percent; volatile material--12 to 35 percent; fixed carbon--7.4 to 24.7 percent; and ash--6 to 57.2 percent. Heat values range from 2,770 to 7,560 Btu per pound.

### Production

Lignite has been mined intermittently from about 1947 until 1960. Since then no lignite has been mined in Arkansas. Data pertaining to the amount of lignite mined in Arkansas are incomplete, but total cumulative production is estimated to be less than 100,000 short tons.

## TEXAS LIGNITES

### Geology

The principal lignite deposits are found in the Wilcox Group (lower Eocene) which contains approximately 80 percent of the resources, while

deposits of secondary importance are found in the Yegua Formation and Jackson Group (upper Eocene). Lignite occurs as a component facies of ancient fluvial, deltaic, and lagoonal rocks in East, Central, Southeast, and South Texas. Lignite-bearing strata dip coastward at one-half to one degree. The highest grade and most extensive resources occur north of the Colorado River in the Wilcox Group of East and Central Texas (figure 4). There is a correlation between grade and geologic occurrence; deltaic lignite is the best grade, fluvial lignite is intermediate in grade, and lagoonal lignite is poorest in grade. The geology of the Texas lignites have been described by Kaiser (6). A stratigraphic occurrence of the Texas lignites is shown in table 3.

## Resources

Identified coal resources in Texas as of January 1, 1974, are set at 16,341 million short tons or about 1 percent of the U.S. total (7). Table 4 shows that more than half of the Texas resources are lignite (10,426 million tons) which occur at depths ranging from 0 to 200 feet in the lower Tertiary of the Gulf Coastal Plain. The remainder is bituminous coal (5,915 million tons) found at levels from 0 to 3,000 feet in three areas in Texas: North-Central, Rio Grande Embayment, and Trans-Pecos. The total statewide lignite resources of 10.4 billion short tons was calculated relying on geologic occurrence, past and current production, reported outcrop occurrences, and projection from deep-basin occurrences.

Texas lignites have the following ranges of composition by proximate analyses: moisture--27.5 to 32.3 percent; volatile matter--33.8 to 35.7 percent; fixed carbon--21.8 to 29.5 percent; and ash--9.1 to 11.0 percent. Heating values ranged 7,124 to 7,916 Btu per pound.

## Production

Since about 1890, lignite has been produced by more than 150 operators in at least 35 Texas counties. Reasonably reliable production figures to date are estimated at 125 million tons (6).

All of the coal currently mined in Texas is strip-mined lignite from north of the Colorado River where zero to 180 feet of unconsolidated overburden is removed. Statewide production in 1976 was 12,300,000 tons, all of which is captive. The oldest producer is ICI America Inc., which has operated a mine in Harrison County at Darco since 1931 for the production of activated carbon. Texas Utilities Generating Company, a subsidiary of Texas Utilities, operates three mines; in Milam County at Alcoa, Freestone County near Fairfield, and Titus County near Monticello. These mines produce 2 to 6 million tons annually for steam-electric plants of 360 to 1,150 MW capacity.

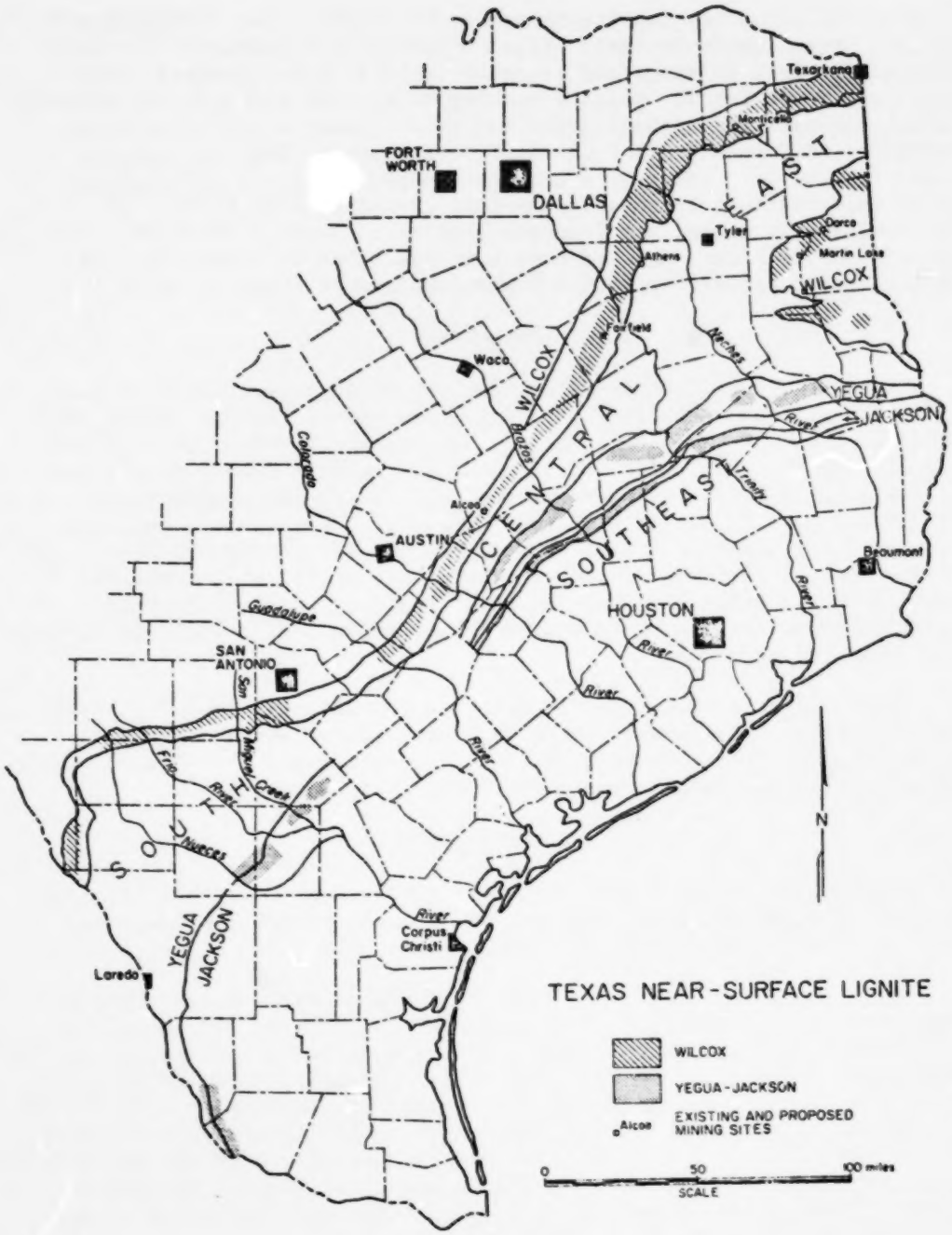


FIGURE 4. - Distribution of Texas near-surface lignite.

TABLE 3. - Stratigraphic occurrence of Texas lignite[1]

| | | East, Southeast, and Central Texas | South Texas |
|---|---|---|---|
| EOCENE SERIES | Jackson Group | Whitsett Formation | Upper |
| | | Manning Formation* | Middle |
| | | Wellborn Formation | Lower* |
| | | Caddell Formation | |
| | Claiborne Group | Yegua Formation* | Upper Yegua* |
| | | Cook Mountain Formation | |
| | | Stone City Formation | Laredo Formation |
| | | Sparta Sand | |
| | | Weches Formation | |
| | | Queen City Sand | El Pico Clay |
| | | Reklaw Formation | Bigford Formation |
| | | Carrizo Sand | Carrizo |
| | Wilcox* Group | Calvert Bluff Formation* | |
| | | Simsboro Sand | |
| | | Hooper Formation | |
| | Lower Wilcox* Group | | Indio Formation* |

*Main lignite occurrences.

Terminology from: Barnes, 1967, 1970, 1974b; Eargle, 1968; Renick, 1936.

[1]Kaiser, W. R. Texas Lignite: Near-Surface and Deep-Basin Resources, Bureau of Economic Geology, R.I.-No. 79, 70 pp.

TABLE 4. - Near-surface potential Texas lignite resources[1]

(In millions of short tons)

| By County and Group | | | | | By Region and Geology | | |
|---|---|---|---|---|---|---|---|
| County | Wilcox | Yegua | Jackson | Yegua-Jackson | | Amount | Percent |
| Angelina | | 174 | | | Regions | | |
| Atascosa | 26 | | | 70 | East Texas | 5,085 | 48.77 |
| Bastrop | 447 | | | | Central Texas | 2,846 | 27.30 |
| Bexar | 78 | | | | Southeast Texas | 1,386 | 13.29 |
| Bowie | 536 | | | | South Texas | 1,109 | 10.64 |
| Brazos | | 39 | 42 | | | 10,426 | 100.00 |
| Burleson | | 121 | 85 | | | | |
| Caldwell | 76 | | | | | | |
| Fayette | | | 102 | | | | |
| Franklin | 156 | | | | Geologic | | |
| Freestone | 967 | | | | Occurrence | | |
| Grimes | | | 63 | | Fluvial | 4,709 | 45.17 |
| Guadalupe | 82 | | | | Deltaic | 4,232 | 40.59 |
| Harrison | 555 | | | | Lagoonal | 1,485 | 14.24 |
| Henderson | 463 | | | | | 10,426 | 100.00 |
| Hopkins | 434 | | | | | | |
| Houston | | 255 | | | | | |
| LaSalle | | | | 86 | | | |
| Lee | 47 | 95 | 41 | | Geologic Trend | | |
| Limestone | 169 | | | | Lower Eocene | | |
| Madison | | 132 | | | (Wilcox) | 8,606 | 82.54 |
| Marion | 60 | | | | Upper Eocene | | |
| Maverick | 129 | | | | (Yegua-Jackson) | 1,820 | 17.46 |
| McMullen | | | | 212 | | 10,426 | 100.00 |
| Medina | 150 | | | | | | |
| Milam | 813 | | | | | | |
| Morris | 89 | | | | | | |
| Nacogdoches | 90 | | | | | | |
| Panola | 524 | | | | | | |
| Rains | 245 | | | | | | |
| Robertson | 403 | | | | | | |
| Rusk | 275 | | | | | | |
| Shelby | 234 | | | | | | |
| Starr | | | | 33 | | | |
| Titus | 444 | | | | | | |
| Trinity | | 20 | 108 | | | | |
| Uvalde | 110 | | | | | | |
| Van Zandt | 782 | | | | | | |
| Walker | | | 17 | | | | |
| Washington | | | 92 | | | | |
| Wood | 198 | | | | | | |
| Zavala | 24 | | | | | | |
| Zapata | | | | 33 | | | |
| | 8,606 | 836 | 550 | 434 | | | |

[1]Kaiser, W. R. Texas Lignite: Near-Surface and Deep Basin Resources, Bureau of Economic Geology, University of Texas, RI No. 79, 1974.

Exploration activity during the past two years has been feverish, and several major companies are actively exploring for lignite. Major emphasis continues to be on the Wilcox group; however, significant activity is occurring in the Yegua-Jackson group.

Five new mines at Martin Lake, Forest Grove, Twin Oaks, Bryan, and San Miguel are scheduled to come on line in 1980 (1). They will provide mine-mouth powerplants with 28 million tons of lignite from the Wilcox and Yegua coalfields.

## EXPERIMENTAL RESULTS

Chemical and physical analyses of the raw coal samples crushed to 14 mesh top size are presented in table 5. The evaluation of the washability data for each coal tested in Arkansas and Texas includes a description of the coalbed section, the washability data, and a short discussion about the data. In some instances a specific gravity of separation is given to illustrate the attainment of a certain quality product. These decisions are arbitrary and should not be construed as suggesting optimum economical plant operating conditions. Results are also presented to show the potential of reducing the sodium-in-ash content of the lignite samples by ion exchange.

### Arkansas Lignite

Channel sample No. 1 was collected from an uncorrelated formation, Wilcox Group (top bench), Dallas County, Arkansas. This coal was from a prospect mine undergoing a feasibility study. A section of the bed is described as follows:

Bed Section[1]

| | Feet | Inches |
|---|---|---|
| Lignite | 3 | 6 |
| Total thickness of bed and sample | 3 | 6 |

[1]Overlying bed: sand, gravel, clay; floor: fireclay.

Table 6 shows the detailed washability analyses of sample No. 1. The composite washability sample contained an average of 11,275 Btu/lb, 11.2 percent ash, 0.44 percent pyritic sulfur, and 0.93 percent total sulfur. The sodium oxide content in the coal was 0.10 percent. Crushing this coal to 3/8 inch top size and removing the sink 1.30 specific gravity material would provide a product analyzing 11,567 Btu/lb, 8.8

TABLE 5. - Chemical and physical analyses of raw coal channel samples

| Type of analysis[1] | Arkansas | | | | Texas | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sample No. 1 | Sample No. 2 | Sample No. 3 | Sample No. 4 | Sample No. 5 | Sample No. 6 | Sample No. 7 | Sample No. 8 | Sample No. 9 | Sample No. 10 | Sample No. 11 |
| Chemical analysis, percent | | | | | | | | | | | |
| Moisture, as received | 34.37 | 31.99 | 29.19 | 32.74 | 25.69 | 28.35 | 30.91 | 29.89 | 33.03 | 31.37 | 32.85 |
| Equilibrium moisture | 35.84 | 32.82 | 32.59 | 36.46 | 30.25 | 28.24 | 31.60 | 31.72 | 32.75 | 28.33 | 37.38 |
| Volatile matter | 51.17 | 52.14 | 47.30 | 33.61 | 45.48 | 47.63 | 46.37 | 41.82 | 43.69 | 42.38 | 48.83 |
| Fixed Carbon | 36.98 | 30.77 | 35.70 | 23.28 | 42.71 | 38.43 | 44.16 | 38.32 | 47.00 | 39.86 | 35.36 |
| Ash | 11.85 | 17.09 | 17.00 | 43.11 | 11.81 | 13.94 | 9.47 | 19.86 | 9.31 | 17.76 | 15.81 |
| Sulfate sulfur | .01 | .01 | .01 | .05 | .02 | .03 | .01 | .01 | .04 | .01 | .01 |
| Pyritic sulfur | .42 | .02 | .77 | .14 | .08 | .22 | .07 | .19 | .36 | .09 | .09 |
| Organic sulfur | .56 | .62 | 1.00 | .85 | .97 | .86 | .70 | 1.18 | .97 | .80 | 1.30 |
| Total sulfur | .99 | .65 | 1.77 | 1.04 | 1.07 | 1.11 | .78 | 1.38 | 1.37 | .90 | 1.40 |
| Hydrogen | 5.14 | 5.21 | 5.14 | 3.16 | 4.72 | 4.69 | 5.00 | 4.36 | 4.70 | 4.34 | 4.88 |
| Carbon | 63.98 | 57.35 | 58.57 | 38.58 | 65.82 | 63.03 | 67.42 | 58.82 | 66.37 | 59.19 | 59.30 |
| Nitrogen | 1.09 | 1.00 | .94 | .66 | .99 | 1.12 | 1.21 | .85 | 1.17 | .93 | 1.03 |
| Oxygen | 16.95 | 18.70 | 15.88 | 13.47 | 15.59 | 16.11 | 16.12 | 14.75 | 17.08 | 16.89 | 17.57 |
| British thermal units per pound | 11,423 | 10,030 | 10,408 | 6,672 | 11,231 | 10,920 | 11,487 | 10,113 | 11,285 | 10,126 | 10,500 |
| Distribution coefficient, n | .7 | .7 | .7 | .7 | .8 | .8 | .8 | .8 | .7 | .8 | .7 |
| Physical Analysis: | | | | | | | | | | | |
| Free-swelling index No. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hardgrove grindability index | 55 | 71 | 53 | 82 | 57 | 57 | 60 | 56 | 63 | 56 | 45 |
| Fusibility of ash, °F: | | | | | | | | | | | |
| Initial deformation temperature | 2,280 | 2,350 | 2,430 | 2,910 | 2,140 | 2,140 | 2,080 | 2,400 | 2,080 | 2,140 | 2,300 |
| Softening temperature | 2,380 | 2,400 | 2,480 | 2,910 | 2,170 | 2,190 | 2,110 | 2,450 | 2,110 | 2,190 | 2,350 |
| Fluid temperature | 2,490 | 2,450 | 2,540 | 2,910 | 2,200 | 2,240 | 2,140 | 2,520 | 2,140 | 2,250 | 2,410 |
| Major elements in ash, percent | | | | | | | | | | | |
| $SiO_2$ | 50.71 | 43.89 | 51.99 | 56.68 | 29.83 | 39.63 | 30.77 | 40.06 | 28.98 | 46.88 | 51.56 |
| $Al_2O_3$ | 23.38 | 26.02 | 24.89 | 29.04 | 14.71 | 16.97 | 13.41 | 25.64 | 12.32 | 18.86 | 22.63 |
| $Fe_2O_3$ | 6.01 | 7.15 | 16.59 | 3.58 | 5.29 | 5.43 | 4.76 | 2.57 | 9.15 | 4.00 | 4.58 |
| $TiO_2$ | 2.33 | 1.33 | 1.00 | 1.00 | 2.33 | 1.00 | 1.12 | 1.67 | 1.67 | 1.67 | 1.00 |
| CaO | 8.40 | 11.19 | 1.12 | 3.08 | 18.19 | 15.39 | 24.10 | 12.59 | 16.79 | 13.29 | 7.64 |
| MgO | 1.53 | 1.23 | .53 | .96 | 9.12 | 2.75 | 4.79 | 2.72 | 5.54 | 2.95 | 1.69 |
| $Na_2O$ | .19 | .19 | .08 | .27 | .98 | .67 | 1.13 | .24 | 1.06 | .65 | 1.27 |
| $K_2O$ | .48 | .24 | .18 | 1.20 | .05 | .24 | .27 | .75 | .24 | .72 | .65 |
| Sulfites | 6.11 | 8.17 | .77 | 3.33 | 17.78 | 14.79 | 16.83 | 11.34 | 17.70 | 8.85 | 8.76 |

[1]All analyses are on moisture-free basis unless otherwise indicated.

TABLE 6. - Detailed washability analyses of sample No. 1

STATE: Arkansas
COUNTY: Dallas

FORMATION: Uncorrelated
GROUP: Wilcox

| Product | Direct: Recovery, pct. Weight | Direct: Recovery, pct. Btu | Direct: Btu/lb | Direct: Percent Ash | Direct: Percent Pyritic sulfur | Direct: Percent Total sulfur | Direct: $Na_2O$[1] | Cumulative: Recovery, pct. Weight | Cumulative: Recovery, pct. Btu | Cumulative: Btu/lb | Cumulative: Percent Ash | Cumulative: Percent Pyritic sulfur | Cumulative: Percent Total sulfur | Cumulative: $Na_2O$[1] | Pounds, $SO_2$/MM Btu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP SIZE: 1-1/2 | | | | | | | | | | | | | | | |
| Size fraction: 1-1/2 x 3/8 | | | | | | | | | | | | | | | |
| Weight percent: 75.1 | | | | | | | | | | | | | | | |
| Float- 1.30 | 98.1 | 98.9 | 11,539 | 9.9 | 0.52 | 0.74 | | 98.1 | 98.9 | 11,539 | 9.9 | 0.52 | 0.74 | | 1.3 |
| 1.30 - 1.40 | .7 | .6 | 9,140 | 26.1 | 2.16 | 2.55 | | 98.8 | 99.5 | 11,521 | 10.0 | .53 | .75 | | 1.3 |
| 1.40 - 1.60 | .8 | .2 | 7,046 | 41.3 | 3.66 | 3.87 | | 99.2 | 99.7 | 11,506 | 10.1 | .54 | .76 | | 1.3 |
| Sink - 1.60 | .8 | .3 | 4,036 | 61.1 | 9.45 | 9.50 | | 100.0 | 100.0 | 11,445 | 10.5 | .62 | .84 | | 1.5 |
| Size fraction: 3/8 x 14 | | | | | | | | | | | | | | | |
| Weight percent: 18.9 | | | | | | | | | | | | | | | |
| Float- 1.30 | 92.0 | 95.2 | 11,528 | 9.0 | 0.17 | 0.77 | | 92.0 | 95.2 | 11,528 | 9.0 | 0.17 | 0.77 | | 1.3 |
| 1.30 - 1.40 | 3.6 | 2.9 | 9,101 | 25.5 | 1.20 | 1.70 | | 95.6 | 98.2 | 11,437 | 9.6 | .21 | .80 | | 1.4 |
| 1.40 - 1.60 | 1.9 | 1.2 | 6,814 | 41.4 | 2.30 | 2.62 | | 97.5 | 99.3 | 11,347 | 10.2 | .25 | .84 | | 1.5 |
| Sink - 1.60 | 2.5 | .7 | 2,970 | 69.0 | 7.75 | 7.78 | | 100.0 | 100.0 | 11,135 | 11.7 | .44 | 1.02 | | 1.8 |
| Size fraction: 14 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 6.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 74.5 | 80.9 | 11,571 | 8.4 | 0.14 | 0.83 | | 74.5 | 80.9 | 11,571 | 8.4 | 0.14 | 0.83 | | 1.4 |
| 1.30 - 1.40 | 13.2 | 12.8 | 10,296 | 17.2 | .36 | 1.07 | | 87.8 | 93.7 | 11,379 | 9.7 | .17 | .87 | | 1.5 |
| 1.40 - 1.60 | 6.1 | 4.6 | 8,078 | 32.2 | .94 | 1.42 | | 93.9 | 98.3 | 11,164 | 11.2 | .22 | .90 | | 1.6 |
| Sink - 1.60 | 6.1 | 1.7 | 2,954 | 69.4 | 2.56 | 2.65 | | 100.0 | 100.0 | 10,661 | 14.8 | .37 | 1.01 | | 1.9 |
| Size composite: 1-1/2 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 95.5 | 97.4 | 11,538 | 9.7 | 0.44 | 0.75 | | 95.5 | 97.4 | 11,538 | 9.7 | 0.44 | 0.75 | | 1.3 |
| 1.30 - 1.40 | 2.0 | 6.2 | 9,581 | 22.4 | 1.13 | 1.68 | | 97.6 | 98.9 | 11,498 | 9.9 | .45 | .77 | | 1.3 |
| 1.40 - 1.60 | 1.0 | 2.2 | 7,344 | 38.0 | 2.16 | 2.51 | | 98.5 | 99.6 | 11,456 | 10.2 | .47 | .79 | | 1.4 |
| Sink - 1.60 | 1.5 | .8 | 3,412 | 65.8 | 7.15 | 7.21 | | 100.0 | 100.0 | 11,339 | 11.0 | .57 | .88 | | 1.6 |
| Minus 100 mesh | 1.7 | 1.6 | 10,583 | 20.9 | 1.05 | 1.86 | | 100.0 | 100.0 | 11,326 | 11.2 | .58 | .90 | | 1.6 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

TABLE 6. - Detailed washability analyses of sample No. 1 (Con.)

STATE: Arkansas
COUNTY: Dallas

FORMATION: Uncorrelated
GROUP: Wilcox

| Product | Direct | | | | | | | Cumulative | | | | | | | Pounds, $SO_2$/MM Btu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Recovery, pct. | | | Percent | | | | Recovery, pct. | | | Percent | | | | |
| | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | |
| TOP SIZE: 3/8 | | | | | | | | | | | | | | | |
| Size fraction: 3/8 x 14 | | | | | | | | | | | | | | | |
| Weight percent: 63.9 | | | | | | | | | | | | | | | |
| Float- 1.30 | 95.5 | 97.1 | 11,529 | 9.0 | 0.15 | 0.77 | | 95.5 | 97.1 | 11,529 | 9.0 | 0.15 | 0.77 | | 1.3 |
| 1.30 - 1.40 | 2.4 | 2.1 | 9,758 | 21.5 | 1.20 | 1.85 | | 97.9 | 99.1 | 11,485 | 9.3 | .18 | .80 | | 1.4 |
| 1.40 - 1.60 | .8 | .5 | 7,110 | 39.0 | 4.49 | 4.71 | | 98.7 | 99.6 | 11,451 | 9.5 | .21 | .83 | | 1.4 |
| Sink - 1.60 | 1.3 | .4 | 3,215 | 66.0 | 14.64 | 14.70 | | 100.0 | 100.0 | 11,342 | 10.3 | .40 | 1.01 | | 1.8 |
| Size fraction: 14 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 36.1 | | | | | | | | | | | | | | | |
| Float- 1.30 | 89.3 | 92.2 | 11,639 | 8.5 | 0.12 | 0.62 | | 89.3 | 92.2 | 11,639 | 8.5 | 0.12 | 0.62 | | 1.1 |
| 1.30 - 1.40 | 6.9 | 5.9 | 9,699 | 21.7 | .57 | 1.03 | | 96.2 | 98.1 | 11,500 | 9.4 | .15 | .65 | | 1.1 |
| 1.40 - 1.60 | 2.0 | 1.4 | 7,728 | 34.3 | 1.67 | 1.78 | | 98.2 | 99.4 | 11,424 | 9.9 | .18 | .67 | | 1.2 |
| Sink - 1.60 | 1.8 | .6 | 3,438 | 64.0 | 4.36 | 4.56 | | 100.0 | 100.0 | 11,277 | 10.9 | .26 | .74 | | 1.3 |
| Size composite: 3/8 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 93.3 | 95.4 | 11,567 | 8.8 | 0.14 | 0.72 | | 93.3 | 95.4 | 11,567 | 8.8 | 0.14 | 0.72 | | 1.2 |
| 1.30 - 1.40 | 4.0 | 4.4 | 9,721 | 21.6 | .81 | 1.35 | | 97.3 | 98.8 | 11,490 | 9.4 | .17 | .74 | | 1.3 |
| 1.40 - 1.60 | 1.2 | 1.0 | 7,477 | 36.2 | 2.81 | 2.97 | | 98.5 | 99.6 | 11,441 | 9.7 | .20 | .77 | | 1.3 |
| Sink - 1.60 | 1.5 | .5 | 3,313 | 65.1 | 10.10 | 10.23 | | 100.0 | 100.0 | 11,318 | 10.5 | .35 | .91 | | 1.6 |
| Minus 100 mesh | 10.2 | 8.8 | 10,677 | 15.6 | .41 | .95 | | 100.0 | 100.0 | 11,259 | 11.0 | .35 | .92 | | 1.6 |
| TOP SIZE: 14 | | | | | | | | | | | | | | | |
| Size fraction: 14 x 0 | | | | | | | | | | | | | | | |
| Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 90.3 | 93.5 | 11,633 | 8.6 | 0.12 | 0.71 | 0.09 | 90.3 | 93.5 | 11,633 | 8.6 | 0.12 | 0.71 | 0.09 | 1.2 |
| 1.30 - 1.40 | 5.1 | 4.4 | 9,776 | 20.6 | .48 | 1.08 | .17 | 95.4 | 97.9 | 11,534 | 9.2 | .14 | .73 | .09 | 1.3 |
| 1.40 - 1.60 | 2.3 | 1.6 | 7,649 | 36.1 | 1.35 | 1.90 | .26 | 97.7 | 99.5 | 11,443 | 9.9 | .17 | .76 | .09 | 1.3 |
| Sink - 1.60 | 2.3 | .5 | 2,609 | 72.7 | 9.36 | 9.40 | .20 | 100.0 | 100.0 | 11,239 | 11.3 | .38 | .96 | .10 | 1.7 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

percent ash, 0.14 percent pyritic sulfur, and 0.72 percent total sulfur at a Btu recovery of 95.4 percent. This coal would now meet the current SO2 emission standard.

Channel sample No. 2 was collected from an uncorrelated formation, Wilcox Group (bottom bench), Dallas County, Arkansas. This coal is from a prospect mine undergoing a feasibility study. A section of the bed is described as follows:

Bed Section[1]

| | Feet | Inches |
|---|---|---|
| Lignite | 9 | 6 |
| Total thickness of bed and sample | 9 | 6 |

[1]Overlying bed: clay, floor: silty clay.

Table 7 shows the detailed washability analyses of sample No. 2. The composite washability sample contained an average of 10,344 Btu/lb, 17.2 percent ash, 0.03 percent pyritic sulfur, and 0.69 percent total sulfur. The sodium oxide content in the coal was 0.04 percent. Crushing this coal to 1-1/2 inches top size and removing the sink 1.40 specific gravity material would provide a product analyzing 10,786 Btu/lb, 14.0 percent ash, 0.02 percent pyritic sulfur, and 0.67 percent total sulfur at a Btu recovery of 97.3 percent. This coal would now meet the EPA $SO_2$ emission standard of 1.2 pounds/MM Btu.

Channel sample No. 3 was collected from an uncorrelated formation, Wilcox Group, Ouachita County, Arkansas. A section of the bed is described as follows:

Bed Section[1]

| | Feet | Inches |
|---|---|---|
| Lignite | 2 | 7 |
| Total thickness of bed and sample | 2 | 7 |

[1]Overlying bed: sandstone; floor: fireclay.

Table 8 shows the detailed washability analyses of sample No. 3. The composite washability sample contained an average of 10,602 Btu/lb, 15.5 percent ash, 0.77 percent pyritic sulfur, and 1.59 percent total sulfur. The sodium oxide content in the coal was 0.01 percent. This sample contained an average of 0.82 percent organic sulfur and could not be upgraded to meet the emission standard of 1.2 pounds $SO_2$/MM Btu. Crushing to 1-1/2 inches top size and removing the sink 1.30 specific

TABLE 7. - Detailed washability analyses of sample No. 2

STATE: Arkansas
COUNTY: Dallas

FORMATION: Uncorrelated
GROUP: Wilcox

| Product | Direct: Recovery, pct. Weight | Direct: Recovery, pct. Btu | Direct: Btu/lb | Direct: Percent Ash | Direct: Percent Pyritic sulfur | Direct: Percent Total sulfur | Direct: $Na_2O$[1] | Cumulative: Recovery, pct. Weight | Cumulative: Recovery, pct. Btu | Cumulative: Btu/lb | Cumulative: Percent Ash | Cumulative: Percent Pyritic sulfur | Cumulative: Percent Total sulfur | Cumulative: $Na_2O$[1] | Pounds, $SO_2$/MM Btu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP SIZE: 1-1/2 | | | | | | | | | | | | | | | |
| Size fraction: 1-1/2 x 3/8 | | | | | | | | | | | | | | | |
| Weight percent: 72.8 | | | | | | | | | | | | | | | |
| Float- 1.30 | 87.9 | 91.8 | 10,915 | 13.1 | 0.02 | 0.68 | | 87.9 | 91.8 | 10,915 | 13.1 | 0.02 | 0.68 | | 1.2 |
| 1.30 - 1.40 | 8.1 | 6.6 | 8,507 | 29.8 | .02 | .61 | | 96.0 | 98.4 | 10,711 | 14.5 | .02 | .67 | | 1.3 |
| 1.40 - 1.60 | 2.1 | 1.2 | 5,723 | 48.7 | .02 | .50 | | 98.1 | 99.6 | 10,603 | 15.3 | .02 | .67 | | 1.3 |
| Sink - 1.60 | 1.9 | .4 | 2,491 | 70.7 | .01 | .29 | | 100.0 | 100.0 | 10,452 | 16.3 | .02 | .66 | | 1.3 |
| Size fraction: 3/8 x 14 | | | | | | | | | | | | | | | |
| Weight percent: 22.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 85.0 | 90.6 | 11,150 | 11.6 | 0.02 | 0.66 | | 85.0 | 90.6 | 11,150 | 11.6 | 0.02 | 0.66 | | 1.2 |
| 1.30 - 1.40 | 7.6 | 6.5 | 8,865 | 27.1 | .02 | .69 | | 92.7 | 97.1 | 10,962 | 12.9 | .02 | .66 | | 1.2 |
| 1.40 - 1.60 | 3.6 | 2.0 | 5,854 | 47.3 | .02 | .50 | | 96.3 | 99.1 | 10,769 | 14.2 | .02 | .66 | | 1.2 |
| Sink - 1.60 | 3.7 | .9 | 2,397 | 71.0 | .08 | .34 | | 100.0 | 100.0 | 10,458 | 16.3 | .02 | .64 | | 1.2 |
| Size fraction: 14 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 5.2 | | | | | | | | | | | | | | | |
| Float- 1.30 | 65.3 | 72.4 | 11,279 | 10.9 | 0.03 | 0.68 | | 65.3 | 72.4 | 11,279 | 10.9 | 0.03 | 0.68 | | 1.2 |
| 1.30 - 1.40 | 4.7 | 5.0 | 10,847 | 13.5 | .04 | .69 | | 70.0 | 77.4 | 11,250 | 11.1 | .03 | .68 | | 1.2 |
| 1.40 - 1.60 | 21.0 | 19.3 | 9,365 | 20.6 | .03 | .73 | | 91.0 | 96.7 | 10,815 | 13.3 | .03 | .69 | | 1.3 |
| Sink - 1.60 | 9.0 | 3.3 | 3,777 | 61.8 | .29 | .63 | | 100.0 | 100.0 | 10,183 | 17.6 | .05 | .69 | | 1.3 |
| Size composite: 1-1/2 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 86.1 | 90.8 | 10,980 | 12.7 | 0.02 | 0.68 | | 86.1 | 90.8 | 10,980 | 12.7 | 0.02 | 0.68 | | 1.2 |
| 1.30 - 1.40 | 7.8 | 6.5 | 8,656 | 28.7 | .02 | .63 | | 93.9 | 97.3 | 10,786 | 14.0 | .02 | .67 | | 1.2 |
| 1.40 - 1.60 | 3.4 | 7.1 | 6,909 | 39.5 | .02 | .57 | | 97.4 | 99.3 | 10,649 | 14.9 | .02 | .67 | | 1.3 |
| Sink - 1.60 | 2.6 | 1.1 | 2,689 | 69.2 | .08 | .37 | | 100.0 | 100.0 | 10,439 | 16.4 | .02 | .66 | | 1.3 |
| Minus 100 mesh | 1.9 | 1.2 | 6,696 | 46.8 | .12 | .50 | | 100.0 | 100.0 | 10,368 | 16.9 | .02 | .66 | | 1.3 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

TABLE 7. - Detailed washability analyses of sample No. 2 (Con.)

STATE: Arkansas
COUNTY: Dallas

FORMATION: Uncorrelated
GROUP: Wilcox

| Product | Direct: Recovery, pct. Weight | Direct: Recovery, pct. Btu | Direct: Btu/lb | Direct: Percent Ash | Direct: Percent Pyritic sulfur | Direct: Percent Total sulfur | Direct: $Na_2O$[1] | Cumulative: Recovery, pct. Weight | Cumulative: Recovery, pct. Btu | Cumulative: Btu/lb | Cumulative: Percent Ash | Cumulative: Percent Pyritic sulfur | Cumulative: Percent Total sulfur | Cumulative: $Na_2O$[1] | Pounds, $SO_2$/MM Btu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP SIZE: 3/8 | | | | | | | | | | | | | | | |
| Size fraction: 3/8 x 14<br>Weight percent: 69.1 | | | | | | | | | | | | | | | |
| Float- 1.30 | 84.8 | 89.1 | 11,071 | 12.3 | 0.05 | 0.67 | | 84.8 | 89.1 | 11,071 | 12.3 | 0.05 | 0.67 | | 1.2 |
| 1.30 - 1.40 | 10.0 | 8.5 | 8,982 | 26.4 | .04 | .64 | | 94.8 | 97.6 | 10,851 | 13.8 | .05 | .67 | | 1.2 |
| 1.40 - 1.60 | 2.8 | 1.8 | 6,773 | 41.2 | .04 | .46 | | 97.5 | 99.4 | 10,735 | 14.6 | .05 | .66 | | 1.2 |
| Sink - 1.60 | 2.5 | .6 | 2,607 | 68.0 | .04 | .29 | | 100.0 | 100.0 | 10,535 | 15.9 | .05 | .65 | | 1.2 |
| Size fraction: 14 x 100<br>Weight percent: 30.9 | | | | | | | | | | | | | | | |
| Float- 1.30 | 72.5 | 78.2 | 11,230 | 11.0 | 0.01 | 0.71 | | 72.5 | 78.2 | 11,230 | 11.0 | 0.01 | 0.71 | | 1.3 |
| 1.30 - 1.40 | 18.5 | 17.4 | 9,751 | 20.1 | .02 | .70 | | 91.0 | 95.5 | 10,929 | 12.9 | .01 | .71 | | 1.3 |
| 1.40 - 1.60 | 4.9 | 3.5 | 7,293 | 36.3 | .02 | .53 | | 96.0 | 99.0 | 10,742 | 14.1 | .01 | .70 | | 1.3 |
| Sink - 1.60 | 4.0 | 1.0 | 2,617 | 68.3 | .12 | .34 | | 100.0 | 100.0 | 10,414 | 16.2 | .02 | .68 | | 1.3 |
| Size composite: 3/8 x 100<br>Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 81.0 | 86.1 | 11,115 | 11.9 | 0.04 | 0.68 | | 81.0 | 86.1 | 11,115 | 11.9 | 0.04 | 0.68 | | 1.2 |
| 1.30 - 1.40 | 12.6 | 12.5 | 9,331 | 23.5 | .03 | .67 | | 93.6 | 97.0 | 10,874 | 13.5 | .04 | .68 | | 1.2 |
| 1.40 - 1.60 | 3.4 | 2.5 | 7,004 | 39.0 | .03 | .49 | | 97.0 | 99.3 | 10,737 | 14.4 | .04 | .67 | | 1.3 |
| Sink - 1.60 | 3.0 | .8 | 2,611 | 68.1 | .07 | .31 | | 100.0 | 100.0 | 10,497 | 16.0 | .04 | .66 | | 1.3 |
| Minus 100 mesh | 11.6 | 8.4 | 8,350 | 33.4 | .04 | .52 | | 100.0 | 100.0 | 10,275 | 17.8 | .04 | .65 | | 1.3 |
| TOP SIZE: 14 | | | | | | | | | | | | | | | |
| Size fraction: 14 x 0<br>Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 78.4 | 84.2 | 11,157 | 12.0 | 0.02 | 0.68 | 0.04 | 78.4 | 84.2 | 11,157 | 12.0 | 0.02 | 0.68 | 0.04 | 1.2 |
| 1.30 - 1.40 | 14.3 | 13.0 | 9,440 | 22.0 | .02 | .73 | .05 | 92.6 | 97.1 | 10,892 | 13.5 | .02 | .69 | .04 | 1.3 |
| 1.40 - 1.60 | 3.9 | 2.5 | 6,541 | 42.4 | .02 | .41 | .03 | 96.5 | 99.6 | 10,717 | 14.7 | .02 | .68 | .04 | 1.3 |
| Sink - 1.60 | 3.5 | .4 | 1,244 | 81.6 | .24 | 3.32 | .01 | 100.0 | 100.0 | 10,389 | 17.0 | .03 | .77 | .04 | 1.5 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

TABLE 8. - Detailed washability analyses of sample No. 3

STATE: Arkansas
COUNTY: Ouachita

FORMATION: Uncorrelated
GROUP: Wilcox

| Product | Direct | | | | | | | Cumulative | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Recovery, pct. | | | Percent | | | | Recovery, pct. | | | Percent | | | | |
| | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | Pounds, $SO_2$/MM Btu |
| TOP SIZE: 1-1/2 | | | | | | | | | | | | | | | |
| Size fraction: 1-1/2 x 3/8<br>Weight percent: 77.6 | | | | | | | | | | | | | | | |
| Float- 1.30 | 93.3 | 95.2 | 11,249 | 11.4 | 0.24 | 1.13 | | 93.3 | 95.2 | 11,249 | 11.4 | 0.24 | 1.13 | | 2.0 |
| 1.30 - 1.40 | 4.0 | 3.2 | 8,896 | 26.1 | 2.24 | 3.07 | | 97.3 | 98.5 | 11,152 | 12.0 | .32 | 1.21 | | 2.2 |
| 1.40 - 1.60 | .9 | .7 | 7,968 | 30.8 | 8.23 | 9.15 | | 98.2 | 99.1 | 11,123 | 12.2 | .40 | 1.28 | | 2.3 |
| Sink - 1.60 | 1.8 | .9 | 5,409 | 46.8 | 25.84 | 26.33 | | 100.0 | 100.0 | 11,020 | 12.8 | .85 | 1.73 | | 3.1 |
| Size fraction: 3/8 x 14<br>Weight percent: 16.2 | | | | | | | | | | | | | | | |
| Float- 1.30 | 86.1 | 89.4 | 11,226 | 10.5 | 0.21 | 1.15 | | 86.1 | 89.4 | 11,226 | 10.5 | 0.21 | 1.15 | | 2.0 |
| 1.30 - 1.40 | 9.4 | 8.1 | 9,311 | 21.3 | .86 | 1.90 | | 95.6 | 97.6 | 11,037 | 11.6 | .27 | 1.22 | | 2.2 |
| 1.40 - 1.60 | 2.8 | 2.0 | 7,771 | 31.1 | 4.09 | 5.45 | | 98.3 | 99.5 | 10,945 | 12.1 | .38 | 1.34 | | 2.5 |
| Sink - 1.60 | 1.7 | .6 | 2,920 | 65.4 | 13.48 | 13.95 | | 100.0 | 100.0 | 10,810 | 13.0 | .60 | 1.55 | | 2.9 |
| Size fraction: 14 x 100<br>Weight percent: 6.2 | | | | | | | | | | | | | | | |
| Float- 1.30 | 28.4 | 52.3 | 11,667 | 9.2 | 0.08 | 1.10 | | 28.4 | 52.3 | 11,667 | 9.2 | 0.08 | 1.10 | | 1.9 |
| 1.30 - 1.40 | 20.1 | 32.3 | 10,198 | 15.3 | .21 | 1.23 | | 48.5 | 84.5 | 11,059 | 11.7 | .13 | 1.15 | | 2.1 |
| 1.40 - 1.60 | 8.7 | 10.9 | 7,964 | 28.4 | .73 | 1.73 | | 57.2 | 95.4 | 10,590 | 14.3 | .22 | 1.24 | | 2.3 |
| Sink - 1.60 | 42.8 | 4.6 | 681 | 92.7 | .31 | .32 | | 100.0 | 100.0 | 6,342 | 47.9 | .26 | .85 | | 2.7 |
| Size composite: 1-1/2 x 100<br>Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 88.1 | 93.5 | 11,253 | 11.2 | 0.23 | 1.13 | | 88.1 | 93.5 | 11,253 | 11.2 | 0.23 | 1.13 | | 2.0 |
| 1.30 - 1.40 | 5.9 | 10.6 | 9,278 | 22.6 | 1.45 | 2.38 | | 94.0 | 97.9 | 11,130 | 11.9 | .31 | 1.21 | | 2.2 |
| 1.40 - 1.60 | 1.7 | 4.3 | 7,914 | 30.1 | 4.74 | 5.81 | | 95.7 | 99.1 | 11,073 | 12.2 | .39 | 1.29 | | 2.3 |
| Sink - 1.60 | 4.3 | 3.1 | 2,347 | 76.2 | 9.38 | 9.57 | | 100.0 | 100.0 | 10,697 | 15.0 | .77 | 1.65 | | 3.1 |
| Minus 100 mesh | 1.5 | 1.0 | 7,047 | 40.8 | .43 | 1.23 | | 100.0 | 100.0 | 10,643 | 15.4 | .77 | 1.64 | | 3.1 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

TABLE 8. - Detailed washability analyses of sample No. 3 (Con.)

STATE: Arkansas
COUNTY: Ouachita

FORMATION: Uncorrelated
GROUP: Wilcox

| Product | Direct | | | | | | | Cumulative | | | | | | | Pounds, $SO_2$/MM Btu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Recovery, pct. | | | Percent | | | | Recovery, pct. | | | Percent | | | | |
| | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | |
| TOP SIZE: 3/8 | | | | | | | | | | | | | | | |
| Size fraction: 3/8 x 14 | | | | | | | | | | | | | | | |
| Weight percent: 61.6 | | | | | | | | | | | | | | | |
| Float- 1.30 | 87.8 | 91.1 | 11,269 | 11.0 | 0.18 | 0.96 | | 87.8 | 91.1 | 11,269 | 11.0 | 0.18 | 0.96 | | 1.7 |
| 1.30 - 1.40 | 7.2 | 6.0 | 9,083 | 24.8 | 1.04 | 1.85 | | 95.0 | 97.2 | 11,103 | 12.0 | .25 | 1.03 | | 1.9 |
| 1.40 - 1.60 | 2.7 | 2.0 | 7,906 | 31.3 | 6.17 | 6.40 | | 97.7 | 99.1 | 11,015 | 12.6 | .41 | 1.17 | | 2.1 |
| Sink - 1.60 | 2.3 | .9 | 4,029 | 55.7 | 24.18 | 24.18 | | 100.0 | 100.0 | 10,852 | 13.6 | .96 | 1.71 | | 3.2 |
| Size fraction: 14 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 38.4 | | | | | | | | | | | | | | | |
| Float- 1.30 | 55.9 | 64.9 | 11,757 | 8.4 | 0.13 | 0.95 | | 55.9 | 64.9 | 11,757 | 8.4 | 0.13 | 0.95 | | 1.6 |
| 1.30 - 1.40 | 27.8 | 28.0 | 10,195 | 16.3 | .32 | 1.16 | | 83.7 | 92.9 | 11,238 | 11.0 | .19 | 1.02 | | 1.8 |
| 1.40 - 1.60 | 6.5 | 5.3 | 8,195 | 27.6 | 1.34 | 2.13 | | 90.2 | 98.2 | 11,018 | 12.2 | .28 | 1.10 | | 2.0 |
| Sink - 1.60 | 9.8 | 1.8 | 1,843 | 82.3 | 2.80 | 2.95 | | 100.0 | 100.0 | 10,121 | 19.1 | .52 | 1.28 | | 2.5 |
| Size composite: 3/8 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 75.5 | 83.7 | 11,407 | 10.3 | 0.17 | 0.96 | | 75.5 | 83.7 | 11,407 | 10.3 | 0.17 | 0.96 | | 1.7 |
| 1.30 - 1.40 | 15.1 | 21.6 | 9,868 | 18.8 | .53 | 1.36 | | 90.6 | 95.7 | 11,151 | 11.7 | .23 | 1.02 | | 1.8 |
| 1.40 - 1.60 | 4.2 | 4.0 | 8,080 | 29.1 | 3.26 | 3.82 | | 94.8 | 98.8 | 11,016 | 12.4 | .36 | 1.15 | | 2.1 |
| Sink - 1.60 | 5.2 | 1.5 | 2,448 | 74.9 | 8.72 | 8.83 | | 100.0 | 100.0 | 10,571 | 15.7 | .79 | 1.33 | | 2.9 |
| Minus 100 mesh | 12.6 | 10.8 | 10,134 | 18.7 | .63 | 1.44 | | 100.0 | 100.0 | 10,522 | 16.0 | .78 | 1.53 | | 2.9 |
| TOP SIZE: 14 | | | | | | | | | | | | | | | |
| Size fraction: 14 x 0 | | | | | | | | | | | | | | | |
| Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 77.7 | 84.1 | 11,520 | 9.5 | 0.13 | 1.01 | 0.01 | 77.7 | 84.1 | 11,520 | 9.5 | 0.13 | 1.01 | 0.01 | 1.8 |
| 1.30 - 1.40 | 12.7 | 11.5 | 9,700 | 18.7 | 0.31 | 1.11 | .01 | 90.4 | 95.6 | 11,265 | 10.8 | .16 | 1.02 | .01 | 1.8 |
| 1.40 - 1.60 | 3.8 | 2.6 | 7,322 | 35.0 | 2.47 | 3.20 | .01 | 94.1 | 98.2 | 11,107 | 11.8 | .25 | 1.11 | .01 | 2.0 |
| Sink - 1.60 | 5.9 | 1.8 | 3,188 | 67.8 | 9.14 | 9.24 | .01 | 100.0 | 100.0 | 10,642 | 15.0 | .77 | 1.59 | .01 | 3.0 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

gravity material would reduce the pyritic sulfur content 70 percent and reduce the $SO_2$ emissions from 3.1 to 2.0 pounds/MM Btu at a Btu recovery of 93.5 percent. This sample was taken from an outcropping near an abandoned strip mine.

Channel sample No. 4 was collected from an uncorrelated formation, Wilcox Group, Saline County, Arkansas. A section of the bed is described as follows:

Bed Section[1]

| | Feet | Inches |
|---|---|---|
| Carbonaceous shale | 0 | 2 |
| Lignite | 2 | 11 |
| Total thickness of bed and sample | 3 | 1 |

[1]Overlying bed: shale; floor: fireclay.

Table 9 shows the detailed washability analyses of sample No. 4. The composite washability sample contained an average of 6,410 Btu/lb, 41.0 percent ash, 0.15 percent pyritic sulfur, and 1.07 percent total sulfur. The sodium oxide content in the coal was 0.08 percent. This sample could not be upgraded to meet the current $SO_2$ emission standard since it contained an average of 0.92 percent organic sulfur. This sample was taken from a lignite bed associated with a bauxite mine. The lignite, however, is not being mined at this time.

## Texas Lignite

Channel sample No. 5 was collected from the Lower Calvert formation, Wilcox Group, Freestone County, Texas. A section of the bed is described as follows:

Bed Section[1]

| | Feet | Inches |
|---|---|---|
| Lignite | 5 | 6 |
| Total thickness of bed and sample | 5 | 6 |

[1]Overlying bed: shale; floor: fireclay.

Table 10 shows the detailed washability analyses of sample No. 5. The composite washability sample contained an average of 11,213 Btu/lb, 10.2 percent ash, 0.09 percent pyritic sulfur, and 1.02 percent total sulfur. The sodium oxide content of the coal was 0.06 percent. This coal could not be upgraded to meet the current $SO_2$ emission standard

TABLE 9. - Detailed washability analyses of sample No. 4

STATE: Arkansas
COUNTY: Saline

FORMATION: Uncorrelated
GROUP: Wilcox

| Product | Direct | | | | | | | Cumulative | | | | | | | Pounds, $SO_2$/MM Btu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Recovery, pct. | | | Percent | | | | Recovery, pct. | | | Percent | | | | |
| | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | |
| TOP SIZE: 1-1/2 | | | | | | | | | | | | | | | |
| Size fraction: 1-1/2 x 3/8 | | | | | | | | | | | | | | | |
| Weight percent: 80.8 | | | | | | | | | | | | | | | |
| Float- 1.30 | 46.0 | 62.5 | 9,072 | 19.5 | 0.20 | 1.59 | | 46.0 | 62.5 | 9,072 | 19.5 | 0.20 | 1.59 | | 3.5 |
| 1.30 - 1.40 | 13.1 | 14.0 | 7,165 | 34.6 | .15 | 1.25 | | 59.0 | 76.5 | 8,650 | 22.8 | .19 | 1.51 | | 3.5 |
| 1.40 - 1.60 | 20.9 | 15.7 | 5,011 | 52.8 | .10 | .77 | | 80.0 | 92.2 | 7,697 | 30.7 | .17 | 1.32 | | 3.4 |
| Sink - 1.60 | 20.0 | 7.8 | 2,592 | 70.2 | .08 | .43 | | 100.0 | 100.0 | 6,674 | 38.6 | .15 | 1.14 | | 3.4 |
| Size fraction: 3/8 x 14 | | | | | | | | | | | | | | | |
| Weight percent: 15.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 32.9 | 49.7 | 9,519 | 17.3 | 0.14 | 1.50 | | 32.9 | 49.7 | 9,519 | 17.3 | 0.14 | 1.50 | | 3.2 |
| 1.30 - 1.40 | 14.0 | 17.0 | 7,655 | 31.3 | .12 | 1.30 | | 46.9 | 66.7 | 8,963 | 21.5 | .13 | 1.44 | | 3.2 |
| 1.40 - 1.60 | 26.6 | 23.4 | 5,556 | 48.6 | .16 | .96 | | 73.5 | 90.1 | 7,720 | 31.3 | .14 | 1.27 | | 3.3 |
| Sink - 1.60 | 26.5 | 9.9 | 2,351 | 71.9 | .47 | .77 | | 100.0 | 100.0 | 6,306 | 42.0 | .23 | 1.14 | | 3.6 |
| Size fraction: 14 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 4.1 | | | | | | | | | | | | | | | |
| Float- 1.30 | 17.2 | 30.5 | 10,042 | 13.8 | 0.09 | 1.56 | | 17.2 | 30.5 | 10,042 | 13.8 | 0.09 | 1.56 | | 3.1 |
| 1.30 - 1.40 | 11.3 | 17.2 | 8,633 | 24.4 | .11 | 1.39 | | 28.5 | 47.7 | 9,483 | 18.0 | .10 | 1.49 | | 3.1 |
| 1.40 - 1.60 | 25.1 | 29.1 | 6,584 | 39.3 | .18 | 1.15 | | 53.6 | 76.9 | 8,127 | 28.0 | .14 | 1.33 | | 3.3 |
| Sink - 1.60 | 46.4 | 23.1 | 2,828 | 67.7 | .59 | .87 | | 100.0 | 100.0 | 5,668 | 46.4 | .35 | 1.12 | | 3.9 |
| Size composite: 1-1/2 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 42.8 | 60.5 | 9,139 | 19.2 | 0.19 | 1.58 | | 42.8 | 60.5 | 9,139 | 19.2 | 0.19 | 1.58 | | 3.5 |
| 1.30 - 1.40 | 13.1 | 14.6 | 7,296 | 33.7 | .14 | 1.26 | | 55.9 | 74.6 | 8,707 | 22.6 | .18 | 1.50 | | 3.5 |
| 1.40 - 1.60 | 22.0 | 17.8 | 5,184 | 51.4 | .11 | .82 | | 77.9 | 91.5 | 7,714 | 30.7 | .16 | 1.31 | | 3.4 |
| Sink - 1.60 | 22.1 | 9.5 | 2,569 | 70.3 | .19 | .53 | | 100.0 | 100.0 | 6,576 | 39.4 | .17 | 1.14 | | 3.5 |
| Minus 100 mesh | 1.0 | 1.0 | 6,475 | 42.4 | .67 | 1.52 | | 100.0 | 100.0 | 6,575 | 39.5 | .17 | 1.14 | | 3.5 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

TABLE 9. - Detailed washability analyses of sample No. 4 (Con.)

STATE: Arkansas
COUNTY: Saline

FORMATION: Uncorrelated
GROUP: Wilcox

| Product | Direct: Recovery, pct. Weight | Direct: Recovery, pct. Btu | Direct: Btu/lb | Direct: Percent Ash | Direct: Percent Pyritic sulfur | Direct: Percent Total sulfur | Direct: Percent $Na_2O$[1] | Cumulative: Recovery, pct. Weight | Cumulative: Recovery, pct. Btu | Cumulative: Btu/lb | Cumulative: Percent Ash | Cumulative: Percent Pyritic sulfur | Cumulative: Percent Total sulfur | Cumulative: Percent $Na_2O$[1] | Pounds, $SO_2$/MM Btu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP SIZE: 3/8 | | | | | | | | | | | | | | | |
| Size fraction: 3/8 x 14<br>Weight percent: 76.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 40.9 | 58.7 | 9,552 | 17.8 | 0.13 | 1.52 | | 40.9 | 58.7 | 9,552 | 17.8 | 0.13 | 1.52 | | 3.2 |
| 1.30 - 1.40 | 13.4 | 14.9 | 7,418 | 34.2 | .12 | 1.23 | | 54.3 | 73.7 | 9,025 | 21.8 | .13 | 1.45 | | 3.2 |
| 1.40 - 1.60 | 21.1 | 17.4 | 5,472 | 50.3 | .15 | .90 | | 75.3 | 91.0 | 8,031 | 29.8 | .13 | 1.29 | | 3.2 |
| Sink - 1.60 | 24.7 | 9.0 | 2,423 | 71.4 | .11 | .39 | | 100.0 | 100.0 | 6,649 | 40.1 | .13 | 1.07 | | 3.2 |
| Size fraction: 14 x 100<br>Weight percent: 24.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 23.1 | 38.0 | 9,873 | 14.4 | .08 | 1.52 | | 23.1 | 38.0 | 9,873 | 14.4 | 0.08 | 1.52 | | 3.1 |
| 1.30 - 1.40 | 15.5 | 21.0 | 8,107 | 27.6 | .12 | 1.35 | | 38.6 | 59.0 | 9,163 | 19.7 | .10 | 1.45 | | 3.2 |
| 1.40 - 1.60 | 21.6 | 22.0 | 6,118 | 41.9 | .15 | .98 | | 60.2 | 81.0 | 8,072 | 27.7 | .12 | 1.28 | | 3.2 |
| Sink - 1.60 | 39.8 | 19.0 | 2,871 | 67.4 | .24 | .61 | | 100.0 | 100.0 | 6,002 | 43.5 | .16 | 1.01 | | 3.4 |
| Size composite: 3/8 x 100<br>Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 36.6 | 55.6 | 9,600 | 17.3 | 0.12 | 1.52 | | 36.6 | 55.6 | 9,600 | 17.3 | 0.12 | 1.52 | | 3.2 |
| 1.30 - 1.40 | 13.9 | 16.6 | 7,602 | 32.4 | .12 | 1.26 | | 50.5 | 71.0 | 9,050 | 21.5 | .12 | 1.45 | | 3.2 |
| 1.40 - 1.60 | 21.2 | 18.5 | 5,629 | 48.3 | .15 | .92 | | 71.7 | 89.0 | 8,039 | 29.4 | .13 | 1.29 | | 3.2 |
| Sink - 1.60 | 28.3 | 12.4 | 2,574 | 70.1 | .15 | .46 | | 100.0 | 100.0 | 6,493 | 40.9 | .14 | 1.06 | | 3.3 |
| Minus 100 mesh | 5.6 | 4.8 | 5,880 | 45.2 | .49 | 1.29 | | 100.0 | 100.0 | 6,461 | 41.1 | .16 | 1.07 | | 3.3 |
| TOP SIZE: 14 | | | | | | | | | | | | | | | |
| Size fraction: 14 x 0<br>Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 26.7 | 42.3 | 9,830 | 16.1 | 0.09 | 1.47 | 0.06 | 26.7 | 42.3 | 9,830 | 16.1 | 0.09 | 1.47 | 0.06 | 3.0 |
| 1.30 - 1.40 | 15.7 | 20.4 | 8,032 | 29.4 | .10 | 1.35 | .07 | 42.4 | 62.7 | 9,164 | 21.0 | .09 | 1.43 | .06 | 3.1 |
| 1.40 - 1.60 | 28.3 | 25.6 | 5,607 | 48.1 | .14 | .95 | .09 | 70.6 | 88.3 | 7,741 | 31.9 | .11 | 1.24 | .07 | 3.2 |
| Sink - 1.60 | 29.4 | 11.7 | 2,479 | 71.2 | .17 | .45 | .11 | 100.0 | 100.0 | 6,196 | 43.4 | .13 | 1.00 | .08 | 3.2 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

TABLE 10. - Detailed washability analyses of sample No. 5

STATE: Texas
COUNTY: Freestone

FORMATION: Lower Calvert
GROUP: Wilcox

| Product | Direct: Recovery, pct. Weight | Direct: Recovery, pct. Btu | Direct: Btu/lb | Direct: Percent Ash | Direct: Percent Pyritic sulfur | Direct: Percent Total sulfur | Direct: $Na_2O$[1] | Cumulative: Recovery, pct. Weight | Cumulative: Recovery, pct. Btu | Cumulative: Btu/lb | Cumulative: Percent Ash | Cumulative: Percent Pyritic sulfur | Cumulative: Percent Total sulfur | Cumulative: $Na_2O$[1] | Pounds, $SO_2$/MM Btu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP SIZE: 1-1/2 | | | | | | | | | | | | | | | |
| Size fraction: 1-1/2 x 3/8 | | | | | | | | | | | | | | | |
| Weight percent: 77.7 | | | | | | | | | | | | | | | |
| Float- 1.30 | 96.8 | 97.2 | 11,303 | 9.7 | 0.01 | 0.77 | | 96.8 | 97.2 | 11,303 | 9.7 | 0.01 | 0.77 | | 1.4 |
| 1.30 - 1.40 | 2.8 | 2.6 | 10,331 | 16.3 | .02 | .77 | | 99.6 | 99.8 | 11,277 | 9.9 | .01 | .77 | | 1.4 |
| 1.40 - 1.60 | .2 | .2 | 8,710 | 29.2 | .35 | 1.62 | | 99.8 | 99.9 | 11,272 | 9.9 | .01 | .77 | | 1.4 |
| Sink - 1.60 | .2 | .1 | 4,717 | 50.6 | 19.99 | 22.20 | | 100.0 | 100.0 | 11,259 | 10.0 | .05 | .81 | | 1.4 |
| Size fraction: 3/8 x 14 | | | | | | | | | | | | | | | |
| Weight percent: 17.9 | | | | | | | | | | | | | | | |
| Float- 1.30 | 68.2 | 70.6 | 11,419 | 8.4 | 0.04 | 0.97 | | 68.2 | 70.6 | 11,419 | 8.4 | 0.04 | 0.97 | | 1.7 |
| 1.30 - 1.40 | 28.2 | 27.3 | 10,679 | 12.6 | .02 | 0.89 | | 96.4 | 97.9 | 11,203 | 9.6 | .03 | .95 | | 1.7 |
| 1.40 - 1.60 | 2.0 | 1.6 | 8,897 | 25.5 | .08 | .76 | | 98.4 | 99.6 | 11,155 | 10.0 | .04 | .94 | | 1.7 |
| Sink - 1.60 | 1.6 | .4 | 3,004 | 63.0 | 8.86 | 10.01 | | 100.0 | 100.0 | 11,024 | 10.8 | .18 | 1.09 | | 2.0 |
| Size fraction: 14 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 4.4 | | | | | | | | | | | | | | | |
| Float- 1.30 | 7.5 | 8.4 | 11,927 | 7.8 | 0.13 | 1.11 | | 7.5 | 8.4 | 11,927 | 7.8 | 0.13 | 1.11 | | 1.9 |
| 1.30 - 1.40 | 69.0 | 74.1 | 11,311 | 8.2 | .02 | .98 | | 76.5 | 82.5 | 11,371 | 8.2 | .03 | .99 | | 1.7 |
| 1.40 - 1.60 | 15.6 | 15.1 | 10,210 | 14.5 | .03 | .88 | | 92.1 | 97.6 | 11,174 | 9.2 | .03 | .97 | | 1.7 |
| Sink - 1.60 | 7.9 | 2.4 | 3,143 | 55.0 | 1.06 | 1.69 | | 100.0 | 100.0 | 10,537 | 12.9 | .11 | 1.03 | | 2.0 |
| Size composite: 1-1/2 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 87.7 | 93.1 | 11,321 | 9.5 | 0.01 | 0.80 | | 87.7 | 93.1 | 11,321 | 9.5 | 0.01 | 0.80 | | 1.4 |
| 1.30 - 1.40 | 10.3 | 35.9 | 10,802 | 12.1 | .02 | .89 | | 98.0 | 98.8 | 11,266 | 9.8 | .02 | .81 | | 1.4 |
| 1.40 - 1.60 | 1.2 | 9.2 | 9,626 | 19.7 | .09 | .94 | | 99.2 | 99.8 | 11,247 | 9.9 | .02 | .81 | | 1.4 |
| Sink - 1.60 | .8 | 1.2 | 3,396 | 57.1 | 7.56 | 8.68 | | 100.0 | 100.0 | 11,184 | 10.3 | .08 | .87 | | 1.6 |
| Minus 100 mesh | .6 | .5 | 9,893 | 19.8 | .13 | 1.12 | | 100.0 | 100.0 | 11,177 | 10.3 | .08 | .87 | | 1.6 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

TABLE 10. - Detailed washability analyses of sample No. 5 (Con.)

STATE: Texas
COUNTY: Freestone

FORMATION: Lower Calvert
GROUP: Wilcox

| Product | Direct | | | | | | | Cumulative | | | | | | | Pounds, $SO_2$/MM Btu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Recovery, pct. | | | Percent | | | | Recovery, pct. | | | Percent | | | | |
| | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | |
| TOP SIZE: 3/8 | | | | | | | | | | | | | | | |
| Size fraction: 3/8 x 14<br>Weight percent: 65.3 | | | | | | | | | | | | | | | |
| Float- 1.30 | 79.1 | 80.6 | 11,441 | 8.0 | 0.01 | 0.97 | | 79.1 | 80.6 | 11,441 | 8.0 | 0.01 | 0.97 | | 1.7 |
| 1.30 - 1.40 | 19.1 | 18.2 | 10,708 | 13.3 | .01 | .95 | | 98.2 | 98.8 | 11,298 | 9.0 | .01 | .97 | | 1.7 |
| 1.40 - 1.60 | 1.1 | .9 | 9,217 | 24.2 | .05 | .80 | | 99.3 | 99.8 | 11,274 | 9.2 | .01 | .96 | | 1.7 |
| Sink - 1.60 | .7 | .2 | 4,064 | 57.8 | 14.52 | 15.99 | | 100.0 | 100.0 | 11,225 | 9.5 | .11 | 1.07 | | 1.9 |
| Size fraction: 14 x 100<br>Weight percent: 34.7 | | | | | | | | | | | | | | | |
| Float- 1.30 | 20.4 | 21.9 | 11,889 | 6.9 | 0.05 | 1.05 | | 20.4 | 21.9 | 11,889 | 6.9 | 0.05 | 1.05 | | 1.8 |
| 1.30 - 1.40 | 67.4 | 68.4 | 11,249 | 8.8 | .03 | .98 | | 87.8 | 90.2 | 11,398 | 8.4 | .03 | 1.00 | | 1.7 |
| 1.40 - 1.60 | 10.0 | 9.0 | 10,041 | 16.3 | .02 | .87 | | 97.8 | 99.2 | 11,259 | 9.2 | .03 | .98 | | 1.7 |
| Sink - 1.60 | 2.2 | .8 | 3,883 | 57.0 | 1.70 | 2.17 | | 100.0 | 100.0 | 11,097 | 10.2 | .07 | 1.01 | | 1.8 |
| Size composite: 3/8 x 100<br>Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 58.7 | 73.5 | 11,494 | 7.9 | 0.01 | 0.98 | | 58.7 | 73.5 | 11,494 | 7.9 | 0.01 | 0.98 | | 1.7 |
| 1.30 - 1.40 | 35.8 | 50.9 | 11,060 | 10.4 | .02 | .97 | | 94.6 | 96.0 | 11,330 | 8.8 | .02 | .98 | | 1.7 |
| 1.40 - 1.60 | 4.2 | 7.6 | 9,894 | 17.7 | .03 | .86 | | 98.8 | 99.6 | 11,269 | 9.2 | .02 | .97 | | 1.7 |
| Sink - 1.60 | 1.2 | .6 | 3,949 | 57.3 | 6.43 | 7.27 | | 100.0 | 100.0 | 11,180 | 9.8 | .10 | 1.05 | | 1.9 |
| Minus 100 mesh | 10.3 | 9.1 | 10,875 | 13.2 | .06 | 1.02 | | 100.0 | 100.0 | 11,152 | 10.1 | .09 | 1.04 | | 1.9 |
| TOP SIZE: 14 | | | | | | | | | | | | | | | |
| Size fraction: 14 x 0<br>Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 22.0 | 23.2 | 11,975 | 7.2 | 0.03 | 0.97 | 0.03 | 22.0 | 23.2 | 11,975 | 7.2 | 0.03 | 0.97 | 0.03 | 1.6 |
| 1.30 - 1.40 | 66.7 | 68.0 | 11,528 | 8.6 | .02 | .98 | .08 | 88.7 | 91.2 | 11,639 | 8.3 | .02 | .98 | .06 | 1.7 |
| 1.40 - 1.60 | 9.2 | 8.2 | 10,089 | 16.0 | .03 | .90 | .07 | 97.8 | 99.4 | 11,494 | 9.0 | .02 | .97 | .06 | 1.7 |
| Sink - 1.60 | 2.2 | .6 | 3,112 | 63.4 | 3.06 | 3.68 | .06 | 100.0 | 100.0 | 11,311 | 10.2 | .09 | 1.03 | .06 | 1.8 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

since the average organic sulfur content was 0.93 percent. This coal contained relatively low ash and there would be little benefit to fine size crushing. None of this coal is washed.

Channel sample No. 6 was collected from the Lower Calvert formation, Wilcox Group, Freestone County, Texas. A section of the bed is described as follows:

Bed Section[1]

| | Feet | Inches |
|---|---|---|
| Lignite | 5 | 4 |
| Total thickness of bed and sample | 5 | 4 |

[1]Overlying bed: shale; floor: fireclay.

Table 11 shows the detailed washability analyses of sample No. 6. The composite washability sample contained an average of 10,851 Btu/lb, 13.3 percent ash, 0.36 percent pyritic sulfur, and 1.16 percent total sulfur. The sodium oxide content in the coal was 0.03 percent. Since this coal contained an average of 0.80 percent organic sulfur, it could not be upgraded to meet the current $SO_2$ emission standard. Crushing to 14 mesh top size and removing the sink 1.40 specific gravity material would provide a product analyzing 9.9 percent ash which would represent an ash reduction of 27 percent. None of this coal is washed.

Channel sample No. 7 was collected from an uncorrelated formation, Wilcox Group, Harrison County, Texas. A section of the bed is described as follows:

Bed Section[1]

| | Feet | Inches |
|---|---|---|
| Lignite | 7 | 2 |
| Total thickness of bed and sample | 7 | 2 |

[1]Overlying bed: shale; floor: fireclay.

Table 12 shows the detailed washability analyses of sample No. 7. The composite washability sample contained an average of 11,263 Btu/lb, 9.3 percent ash, 0.07 percent pyritic sulfur, and 0.80 percent total sulfur. The sodium oxide content in the coal was 0.11 percent. This sample could not be upgraded to meet the current $SO_2$ emission standard since it contained an average of 0.73 percent organic sulfur. The ash content of this coal was low and crushing would provide minimal benefit. None of this coal is washed.

TABLE 11. - Detailed washability analyses of sample No. 6

STATE: Texas
COUNTY: Freestone

FORMATION: Lower Calvert
GROUP: Wilcox

| Product | Direct | | | | | | | Cumulative | | | | | | | Pounds, $SO_2$/MM Btu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Recovery, pct. | | | Percent | | | | Recovery, pct. | | | Percent | | | | |
| | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | |
| TOP SIZE: 1-1/2 | | | | | | | | | | | | | | | |
| Size fraction: 1-1/2 x 3/8 | | | | | | | | | | | | | | | |
| Weight percent: 77.3 | | | | | | | | | | | | | | | |
| Float - 1.30 | 84.7 | 87.5 | 11,249 | 10.5 | 0.11 | 0.97 | | 84.7 | 87.5 | 11,249 | 10.5 | 0.11 | 0.97 | | 1.7 |
| 1.30 - 1.40 | 11.0 | 10.0 | 9,869 | 20.0 | .17 | .99 | | 95.8 | 97.5 | 11,090 | 11.6 | .12 | .97 | | 1.8 |
| 1.40 - 1.60 | 2.9 | 1.9 | 7,112 | 40.2 | .55 | 1.20 | | 98.7 | 99.5 | 10,972 | 12.4 | .13 | .98 | | 1.8 |
| Sink - 1.60 | 1.3 | .5 | 4,538 | 53.8 | 7.81 | 7.81 | | 100.0 | 100.0 | 10,888 | 13.0 | .23 | 1.07 | | 2.0 |
| Size fraction: 3/8 x 14 | | | | | | | | | | | | | | | |
| Weight percent: 18.7 | | | | | | | | | | | | | | | |
| Float- 1.30 | 73.0 | 77.6 | 11,351 | 9.1 | 0.09 | 0.99 | | 73.0 | 77.6 | 11,351 | 9.1 | 0.09 | 0.99 | | 1.7 |
| 1.30 - 1.40 | 18.9 | 18.0 | 10,150 | 17.6 | .22 | 1.06 | | 91.9 | 95.6 | 11,104 | 10.9 | .12 | 1.00 | | 1.8 |
| 1.40 - 1.60 | 4.3 | 3.0 | 7,515 | 36.0 | .72 | 1.31 | | 96.2 | 98.6 | 10,943 | 12.0 | .14 | 1.02 | | 1.9 |
| Sink - 1.60 | 3.8 | 1.4 | 3,907 | 55.2 | 10.16 | 10.19 | | 100.0 | 100.0 | 10,678 | 13.6 | .52 | 1.36 | | 2.6 |
| Size fraction: 14 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 3.9 | | | | | | | | | | | | | | | |
| Float- 1.30 | 9.0 | 10.6 | 11,884 | 7.2 | 0.10 | 1.02 | | 9.0 | 10.6 | 11,884 | 7.2 | 0.10 | 1.02 | | 1.7 |
| 1.30 - 1.40 | 64.1 | 70.9 | 11,246 | 9.8 | .09 | .98 | | 73.2 | 81.4 | 11,325 | 9.5 | .09 | .98 | | 1.7 |
| 1.40 - 1.60 | 14.6 | 13.6 | 9,478 | 20.0 | .29 | 1.06 | | 87.7 | 95.0 | 11,018 | 11.2 | .12 | 1.00 | | 1.8 |
| Sink - 1.60 | 12.3 | 5.0 | 4,152 | 54.3 | 3.09 | 3.84 | | 100.0 | 100.0 | 10,177 | 16.5 | .49 | 1.35 | | 2.6 |
| Size composite: 1-1/2 x 100 | | | | | | | | | | | | | | | |
| Weight percent. 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 79.6 | 85.5 | 11,269 | 10.2 | 0.11 | 0.97 | | 79.6 | 85.5 | 11,269 | 10.2 | 0.11 | 0.97 | | 1.7 |
| 1.30 - 1.40 | 14.6 | 22.5 | 10,175 | 17.7 | .17 | 1.01 | | 94.2 | 96.7 | 11,099 | 11.4 | .12 | .98 | | 1.8 |
| 1.40 - 1.60 | 3.7 | 4.0 | 7,572 | 36.1 | .55 | 1.20 | | 97.8 | 99.1 | 10,967 | 12.3 | .13 | .99 | | 1.8 |
| Sink - 1.60 | 2.2 | 1.8 | 4,250 | 54.4 | 7.53 | 7.70 | | 100.0 | 100.0 | 10,820 | 13.2 | .29 | 1.13 | | 2.1 |
| Minus 100 mesh | .7 | .6 | 9,357 | 24.0 | .61 | 1.45 | | 100.0 | 100.0 | 10,811 | 13.3 | .30 | 1.14 | | 2.1 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

TABLE 11. - Detailed washability analyses of sample No. 6 (Con.)

STATE: Texas
COUNTY: Freestone

FORMATION: Lower Calvert
GROUP: Wilcox

| Product | Direct | | | | | | | Cumulative | | | | | | | Pounds, $SO_2$/MM Btu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Recovery, pct. | | | Percent | | | | Recovery, pct. | | | Percent | | | | |
| | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | |
| TOP SIZE: 3/8 | | | | | | | | | | | | | | | |
| Size fraction: 3/8 x 14 | | | | | | | | | | | | | | | |
| Weight percent: 63.4 | | | | | | | | | | | | | | | |
| Float- 1.30 | 75.2 | 78.4 | 11,429 | 8.8 | 0.07 | 0.92 | | 75.2 | 78.4 | 11,429 | 8.8 | 0.07 | 0.92 | | 1.6 |
| 1.30 - 1.40 | 19.2 | 18.0 | 10,301 | 16.3 | .16 | .97 | | 94.4 | 96.4 | 11,200 | 10.3 | .09 | .93 | | 1.7 |
| 1.40 - 1.60 | 3.6 | 2.6 | 8,069 | 32.3 | .29 | .96 | | 98.0 | 99.0 | 11,086 | 11.1 | .10 | .93 | | 1.7 |
| Sink - 1.60 | 2.0 | 1.0 | 5,391 | 47.9 | 9.14 | 9.52 | | 100.0 | 100.0 | 10,970 | 11.9 | .28 | 1.11 | | 2.0 |
| Size fraction: 14 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 36.6 | | | | | | | | | | | | | | | |
| Float- 1.30 | 39.7 | 42.8 | 11,777 | 7.6 | 0.06 | 0.95 | | 39.7 | 42.8 | 11,777 | 7.6 | 0.06 | 0.95 | | 1.6 |
| 1.30 - 1.40 | 50.1 | 50.4 | 11,035 | 11.6 | .10 | .95 | | 89.8 | 93.5 | 11,363 | 9.8 | .08 | .95 | | 1.7 |
| 1.40 - 1.60 | 6.7 | 5.1 | 8,337 | 28.3 | .44 | 1.01 | | 96.5 | 98.6 | 11,152 | 11.1 | .11 | .95 | | 1.7 |
| Sink - 1.60 | 3.5 | 1.4 | 4,478 | 52.4 | 4.64 | 5.15 | | 100.0 | 100.0 | 10,922 | 12.5 | .26 | 1.10 | | 2.0 |
| Size composite: 3/8 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 62.2 | 70.0 | 11,510 | 8.5 | 0.07 | 0.93 | | 62.2 | 70.0 | 11,510 | 8.5 | 0.07 | .93 | | 1.6 |
| 1.30 - 1.40 | 30.5 | 37.7 | 10,742 | 13.5 | .12 | .96 | | 92.7 | 95.3 | 11,257 | 10.1 | .09 | .94 | | 1.7 |
| 1.40 - 1.60 | 4.7 | 3.9 | 8,208 | 30.2 | .37 | .99 | | 97.4 | 98.8 | 11,109 | 11.1 | .10 | .94 | | 1.7 |
| Sink - 1.60 | 2.6 | 1.2 | 4,938 | 50.1 | 6.91 | 7.36 | | 100.0 | 100.0 | 10,952 | 12.1 | .27 | 1.10 | | 2.0 |
| Minus 100 mesh | 9.8 | 8.6 | 10,437 | 16.5 | .30 | 1.20 | | 100.0 | 100.0 | 10,905 | 12.5 | .28 | 1.11 | | 2.0 |
| TOP SIZE: 14 | | | | | | | | | | | | | | | |
| Size fraction: 14 x 0 | | | | | | | | | | | | | | | |
| Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 56.3 | 60.6 | 11,769 | 8.2 | 0.08 | 0.94 | 0.03 | 56.3 | 60.6 | 11,769 | 8.2 | 0.08 | 0.94 | 0.03 | 1.6 |
| 1.30 - 1.40 | 31.6 | 31.8 | 10,984 | 12.9 | .11 | .95 | .03 | 87.9 | 92.4 | 11,487 | 9.9 | .09 | .94 | .03 | 1.6 |
| 1.40 - 1.60 | 8.1 | 6.4 | 8,604 | 28.2 | .33 | 1.06 | .04 | 96.0 | 98.8 | 11,242 | 11.4 | .11 | .95 | .03 | 1.7 |
| Sink - 1.60 | 4.0 | 1.2 | 3,235 | 63.3 | 8.93 | 7.19 | .06 | 100.0 | 100.0 | 10,923 | 13.5 | .46 | 1.20 | .03 | 2.2 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

TABLE 12. - Detailed washability analyses of sample No. 7

STATE: Texas
COUNTY: Harrison

FORMATION: Uncorrelated
GROUP: Wilcox

| Product | Direct | | | | | | | Cumulative | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Recovery, pct. | | | Percent | | | | Recovery, pct. | | | Percent | | | | |
| | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | Pounds, $SO_2$/MM Btu |
| TOP SIZE: 1-1/2 | | | | | | | | | | | | | | | |
| Size fraction: 1-1/2 x 3/8<br>Weight percent: 79.2 | | | | | | | | | | | | | | | |
| Float- 1.30 | 98.8 | 99.1 | 11,320 | 9.2 | 0.06 | 0.77 | | 98.8 | 99.1 | 11,320 | 9.2 | 0.06 | 0.77 | | 1.4 |
| 1.30 - 1.40 | .9 | .8 | 9,631 | 21.9 | .17 | .80 | | 99.7 | 99.8 | 11,305 | 9.3 | .06 | .77 | | 1.4 |
| 1.40 - 1.60 | .2 | .1 | 7,750 | 34.5 | .28 | .66 | | 99.9 | 100.0 | 11,298 | 9.4 | .06 | .77 | | 1.4 |
| Sink - 1.60 | .1 | .0 | 3,250 | 66.3 | .66 | .95 | | 100.0 | 100.0 | 11,289 | 9.4 | .06 | .77 | | 1.4 |
| Size fraction: 3/8 x 14<br>Weight percent: 17.2 | | | | | | | | | | | | | | | |
| Float- 1.30 | 95.2 | 96.4 | 11,246 | 8.7 | 0.04 | 0.83 | | 95.2 | 96.4 | 11,246 | 8.7 | 0.04 | 0.83 | | 1.5 |
| 1.30 - 1.40 | 3.1 | 2.7 | 9,897 | 18.7 | .22 | .83 | | 98.3 | 99.2 | 11,204 | 9.0 | .05 | .83 | | 1.5 |
| 1.40 - 1.60 | 1.0 | .7 | 7,540 | 36.0 | .51 | .92 | | 99.3 | 99.8 | 11,167 | 9.3 | .05 | .83 | | 1.5 |
| Sink - 1.60 | .7 | .2 | 2,450 | 72.0 | 2.88 | 2.93 | | 100.0 | 100.0 | 11,105 | 9.7 | .07 | .85 | | 1.5 |
| Size fraction: 14 x 100<br>Weight percent: 3.5 | | | | | | | | | | | | | | | |
| Float- 1.30 | 56.2 | 58.4 | 11,294 | 8.2 | 0.03 | 0.81 | | 56.2 | 58.4 | 11,294 | 8.2 | 0.03 | 0.81 | | 1.4 |
| 1.30 - 1.40 | 32.6 | 32.9 | 10,949 | 10.4 | .09 | .78 | | 88.7 | 91.3 | 11,167 | 9.0 | .05 | .80 | | 1.4 |
| 1.40 - 1.60 | 8.4 | 7.7 | 9,969 | 15.4 | .20 | .83 | | 97.1 | 99.0 | 11,064 | 9.6 | .06 | .80 | | 1.4 |
| Sink - 1.60 | 2.8 | 1.0 | 3,780 | 62.6 | 2.39 | 2.47 | | 100.0 | 100.0 | 10,853 | 11.1 | .13 | .85 | | 1.6 |
| Size composite: 1-1/2 x 100<br>Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 96.7 | 97.8 | 11,306 | 9.1 | 0.06 | 0.78 | | 96.7 | 97.8 | 11,306 | 9.1 | 0.06 | 0.78 | | 1.4 |
| 1.30 - 1.40 | 2.4 | 16.6 | 10,320 | 15.7 | .14 | .80 | | 99.1 | 99.5 | 11,282 | 9.3 | .06 | .78 | | 1.4 |
| 1.40 - 1.60 | .6 | 3.9 | 8,755 | 25.8 | .30 | .81 | | 99.7 | 99.9 | 11,267 | 9.4 | .06 | .78 | | 1.4 |
| Sink - 1.60 | .3 | .4 | 3,110 | 67.3 | 2.09 | 2.22 | | 100.0 | 100.0 | 11,241 | 9.5 | .07 | .79 | | 1.4 |
| Minus 100 mesh | 1.0 | .9 | 10,225 | 16.6 | .19 | .86 | | 100.0 | 100.0 | 11,231 | 9.6 | .07 | .79 | | 1.4 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

TABLE 12. - Detailed washability analyses of sample No. 7 (Con.)

STATE: Texas
COUNTY: Harrison

FORMATION: Uncorrelated
GROUP: Wilcox

| Product | Direct: Recovery, pct. Weight | Direct: Recovery, pct. Btu | Direct: Btu/lb | Direct: Percent Ash | Direct: Percent Pyritic sulfur | Direct: Percent Total sulfur | Direct: $Na_2O$[1] | Cumulative: Recovery, pct. Weight | Cumulative: Recovery, pct. Btu | Cumulative: Btu/lb | Cumulative: Percent Ash | Cumulative: Percent Pyritic sulfur | Cumulative: Percent Total sulfur | Cumulative: $Na_2O$[1] | Pounds, $SO_2$/MM Btu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP SIZE: 3/8 | | | | | | | | | | | | | | | |
| Size fraction: 3/8 x 14 | | | | | | | | | | | | | | | |
| Weight percent: 64.9 | | | | | | | | | | | | | | | |
| Float- 1.30 | 95.9 | 96.6 | 11,291 | 8.6 | 0.06 | 0.82 | | 95.9 | 96.6 | 11,291 | 8.6 | 0.06 | 0.82 | | 1.5 |
| 1.30 - 1.40 | 3.1 | 2.8 | 10,174 | 17.1 | .20 | .84 | | 99.0 | 99.4 | 11,256 | 8.9 | .06 | .82 | | 1.5 |
| 1.40 - 1.60 | .7 | .5 | 7,660 | 35.1 | .61 | 1.14 | | 99.7 | 99.9 | 11,229 | 9.1 | .07 | .82 | | 1.5 |
| Sink - 1.60 | .3 | .1 | 3,160 | 67.0 | 3.93 | 3.96 | | 100.0 | 100.0 | 11,208 | 9.2 | .08 | .83 | | 1.5 |
| Size fraction: 14 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 35.1 | | | | | | | | | | | | | | | |
| Float- 1.30 | 68.5 | 69.9 | 11,415 | 8.0 | 0.03 | 0.78 | | 68.5 | 69.9 | 11,415 | 8.0 | 0.03 | 0.78 | | 1.4 |
| 1.30 - 1.40 | 26.1 | 25.8 | 11,040 | 10.0 | .06 | .82 | | 94.7 | 95.7 | 11,311 | 8.7 | .04 | .79 | | 1.4 |
| 1.40 - 1.60 | 4.4 | 3.8 | 9,690 | 18.0 | .15 | .80 | | 99.1 | 99.5 | 11,239 | 9.1 | .04 | .79 | | 1.4 |
| Sink - 1.60 | .9 | .5 | 5,330 | 50.6 | 1.57 | 1.94 | | 100.0 | 100.0 | 11,184 | 9.5 | .06 | .80 | | 1.4 |
| Size composite: 3/8 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 86.3 | 89.1 | 11,325 | 8.4 | 0.05 | 0.81 | | 86.3 | 89.1 | 11,325 | 8.4 | 0.05 | 0.81 | | 1.4 |
| 1.30 - 1.40 | 11.2 | 21.7 | 10,883 | 11.8 | .09 | .82 | | 97.5 | 98.2 | 11,274 | 8.8 | .06 | .81 | | 1.4 |
| 1.40 - 1.60 | 2.0 | 3.0 | 9,208 | 22.1 | .26 | .88 | | 99.5 | 99.8 | 11,232 | 9.1 | .06 | .81 | | 1.4 |
| Sink - 1.60 | .5 | .3 | 4,589 | 56.2 | 2.38 | 2.63 | | 100.0 | 100.0 | 11,199 | 9.3 | .07 | .82 | | 1.5 |
| Minus 100 mesh | 11.0 | 9.8 | 11,047 | 11.7 | .10 | .82 | | 100.0 | 100.0 | 11,184 | 9.6 | .07 | .82 | | 1.5 |
| TOP SIZE: 14 | | | | | | | | | | | | | | | |
| Size fraction: 14 x 0 | | | | | | | | | | | | | | | |
| Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 80.7 | 81.7 | 11,523 | 7.7 | 0.04 | 0.80 | 0.11 | 80.7 | 81.7 | 11,523 | 7.7 | 0.04 | 0.80 | 0.11 | 1.4 |
| 1.30 - 1.40 | 17.1 | 16.7 | 11,105 | 10.6 | .09 | .73 | .11 | 97.7 | 98.4 | 11,450 | 8.2 | .05 | .79 | .11 | 1.4 |
| 1.40 - 1.60 | 1.9 | 1.5 | 9,183 | 24.4 | .44 | .84 | .09 | 99.6 | 99.9 | 11,407 | 8.5 | .06 | .79 | .11 | 1.4 |
| Sink - 1.60 | .4 | .1 | 2,972 | 72.1 | 3.08 | 3.10 | .09 | 100.0 | 100.0 | 11,374 | 8.8 | .07 | .80 | .11 | 1.4 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

Channel sample No. 8 was collected from the Lower Calvert formation, Wilcox Group, in Milam County, Texas. A section of the bed is described as follows:

Bed Section[1]

| | Feet | Inches |
|---|---|---|
| Lignite | 3 | 3 |
| Shale | | 7 |
| Lignite | 4 | 1 |
| Shale | | 1 |
| Lignite | 4 | 0 |
| Total thickness of bed and sample | 12 | 0 |

[1]Overlying bed: shale; floor: fireclay.

Table 13 shows the detailed washability analyses of sample No. 8. The composite washability sample contained an average of 9,948 Btu/lb, 19.8 percent ash, 0.15 percent pyritic sulfur, and 1.31 percent total sulfur. The sodium oxide content in the coal was 0.04 percent. This coal could not be upgraded to meet the current $SO_2$ emission standard of 1.2 pounds $SO_2$/MM Btu since it contained an average of 1.16 percent organic sulfur. Crushing to 3/8 inch top size and removing the sink 1.40 specific gravity material of the composite sample would provide a product analyzing 11.5 percent ash at a Btu recovery of 90.1 percent. The ash reduction would be 42 percent. None of this coal is washed.

Channel sample No. 9 was collected from an uncorrelated formation, Wilcox Group, in Panola County, Texas. A section of the bed is described as follows:

Bed Section[1]

| | Feet | Inches |
|---|---|---|
| Lignite | 7 | 7 |
| Total thickness of bed and sample | 7 | 7 |

[1]Overlying bed: shale, floor; fireclay.

Table 14 shows the detailed washability analyses of sample No. 9. The composite washability sample contained an average of 11,200 Btu/lb, 8.6 percent ash, 0.26 percent pyritic sulfur, and 1.32 percent total sulfur. The sodium oxide content of the coal was 0.08 percent. This sample contained an average of 1.06 percent organic sulfur and could not be upgraded to meet the current $SO_2$ emission standard. Crushing to 3/8

TABLE 13. - Detailed washability analyses of sample No. 8

STATE: Texas
COUNTY: Milam

FORMATION: Lower Calvert
GROUP: Wilcox

| Product | Direct: Recovery, pct. Weight | Direct: Recovery, pct. Btu | Direct: Btu/lb | Direct: Percent Ash | Direct: Percent Pyritic sulfur | Direct: Percent Total sulfur | Direct: $Na_2O$[1] | Cumulative: Recovery, pct. Weight | Cumulative: Recovery, pct. Btu | Cumulative: Btu/lb | Cumulative: Percent Ash | Cumulative: Percent Pyritic sulfur | Cumulative: Percent Total sulfur | Cumulative: $Na_2O$[1] | Pounds, $SO_2$/MM Btu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP SIZE: 1-1/2 | | | | | | | | | | | | | | | |
| Size fraction: 1-1/2 x 3/8 | | | | | | | | | | | | | | | |
| Weight percent: 78.5 | | | | | | | | | | | | | | | |
| Float- 1.30 | 79.8 | 86.6 | 11,130 | 11.6 | 0.04 | 1.36 | | 79.8 | 86.6 | 11,130 | 11.6 | 0.04 | 1.36 | | 2.4 |
| 1.30 - 1.40 | 10.2 | 9.3 | 9,321 | 24.6 | .31 | 1.61 | | 90.0 | 95.9 | 10,925 | 13.1 | .07 | 1.39 | | 2.5 |
| 1.40 - 1.60 | 3.7 | 2.6 | 7,114 | 40.6 | .25 | 1.06 | | 93.7 | 98.4 | 10,775 | 14.2 | .08 | 1.38 | | 2.6 |
| Sink - 1.60 | 6.3 | 1.6 | 2,561 | 70.9 | .78 | 1.20 | | 100.0 | 100.0 | 10,261 | 17.7 | .12 | 1.36 | | 2.7 |
| Size fraction: 3/8 x 14 | | | | | | | | | | | | | | | |
| Weight percent: 17.7 | | | | | | | | | | | | | | | |
| Float- 1.30 | 64.6 | 76.9 | 10,959 | 11.8 | 0.06 | 1.44 | | 64.6 | 76.9 | 10,959 | 11.8 | 0.06 | 1.44 | | 2.6 |
| 1.30 - 1.40 | 13.9 | 14.3 | 9,514 | 22.7 | .15 | 1.36 | | 78.5 | 91.2 | 10,764 | 13.7 | .08 | 1.43 | | 2.7 |
| 1.40 - 1.60 | 6.4 | 5.2 | 7,437 | 37.7 | .18 | 1.07 | | 84.9 | 96.4 | 10,458 | 15.5 | .08 | 1.40 | | 2.7 |
| Sink - 1.60 | 15.1 | 3.6 | 2,215 | 74.3 | 1.20 | 1.73 | | 100.0 | 100.0 | 9,210 | 24.4 | .25 | 1.45 | | 3.1 |
| Size fraction: 14 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 3.8 | | | | | | | | | | | | | | | |
| Float- 1.30 | 45.5 | 58.0 | 11,753 | 8.6 | 0.04 | 1.31 | | 45.5 | 58.0 | 11,753 | 8.6 | 0.04 | 1.31 | | 2.2 |
| 1.30 - 1.40 | 17.8 | 21.3 | 11,042 | 12.0 | .07 | 1.37 | | 63.3 | 79.3 | 11,554 | 9.6 | .05 | 1.33 | | 2.3 |
| 1.40 - 1.60 | 14.4 | 13.9 | 8,876 | 26.7 | .16 | 1.26 | | 77.8 | 93.2 | 11,056 | 12.7 | .07 | 1.31 | | 2.4 |
| Sink - 1.60 | 22.2 | 6.8 | 2,828 | 69.9 | .92 | 1.25 | | 100.0 | 100.0 | 9,226 | 25.5 | .26 | 1.30 | | 2.8 |
| Size composite: 1-1/2 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 75.9 | 84.5 | 11,118 | 11.6 | 0.04 | 1.37 | | 75.9 | 84.5 | 11,118 | 11.6 | 0.04 | 1.37 | | 2.5 |
| 1.30 - 1.40 | 11.1 | 11.1 | 9,467 | 23.4 | .26 | 1.54 | | 87.0 | 94.7 | 10,907 | 13.1 | .07 | 1.39 | | 2.6 |
| 1.40 - 1.60 | 4.6 | 4.6 | 7,403 | 38.2 | .22 | 1.09 | | 91.6 | 97.9 | 10,731 | 14.3 | .08 | 1.38 | | 2.6 |
| Sink - 1.60 | 8.4 | 2.7 | 2,477 | 71.9 | .93 | 1.37 | | 100.0 | 100.0 | 10,035 | 19.2 | .15 | 1.38 | | 2.8 |
| Minus 100 mesh | 1.1 | 1.2 | 10,979 | 22.7 | .16 | .94 | | 100.0 | 100.0 | 10,045 | 19.2 | .15 | 1.37 | | 2.7 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

TABLE 13. - Detailed washability analyses of sample No. 8 (Con.)

STATE: Texas
COUNTY: Milam

FORMATION: Lower Calvert
GROUP: Wilcox

| Product | Direct | | | | | | | Cumulative | | | | | | | Pounds, $SO_2$/MM Btu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Recovery, pct. | | | Percent | | | | Recovery, pct. | | | Percent | | | | |
| | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | |
| TOP SIZE: 3/8 | | | | | | | | | | | | | | | |
| Size fraction: 3/8 x 14 | | | | | | | | | | | | | | | |
| Weight percent: 70.2 | | | | | | | | | | | | | | | |
| Float- 1.30 | 69.0 | 78.0 | 11,299 | 10.0 | 0.04 | 1.33 | | 69.0 | 78.0 | 11,299 | 10.0 | 0.04 | 1.33 | | 2.4 |
| 1.30 - 1.40 | 15.0 | 14.7 | 9,796 | 21.0 | .17 | 1.46 | | 84.1 | 92.7 | 11,030 | 12.0 | .06 | 1.35 | | 2.5 |
| 1.40 - 1.60 | 6.8 | 5.1 | 7,481 | 37.3 | .13 | 1.07 | | 90.9 | 97.8 | 10,764 | 13.9 | .07 | 1.33 | | 2.5 |
| Sink - 1.60 | 9.1 | 2.2 | 2,367 | 72.7 | 1.49 | 1.72 | | 100.0 | 100.0 | 9,998 | 19.2 | .20 | 1.37 | | 2.7 |
| Size fraction: 14 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 29.8 | | | | | | | | | | | | | | | |
| Float- 1.30 | 40.6 | 48.0 | 11,700 | 8.3 | 0.02 | 1.32 | | 40.6 | 48.0 | 11,700 | 8.3 | 0.02 | 1.32 | | 2.3 |
| 1.30 - 1.40 | 31.4 | 34.9 | 11,008 | 12.3 | .05 | 1.33 | | 72.0 | 83.0 | 11,398 | 10.0 | .03 | 1.32 | | 2.3 |
| 1.40 - 1.60 | 14.8 | 13.0 | 8,662 | 27.8 | .14 | 1.20 | | 86.8 | 95.9 | 10,932 | 13.1 | .05 | 1.30 | | 2.4 |
| Sink - 1.60 | 13.2 | 4.1 | 3,070 | 67.5 | .62 | .97 | | 100.0 | 100.0 | 9,896 | 20.2 | .13 | 1.26 | | 2.5 |
| Size composite: 3/8 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 60.6 | 72.0 | 11,379 | 9.7 | 0.04 | 1.33 | | 60.6 | 72.0 | 11,379 | 9.7 | 0.04 | 1.33 | | 2.3 |
| 1.30 - 1.40 | 19.9 | 24.2 | 10,365 | 16.9 | .11 | 1.40 | | 80.5 | 90.1 | 11,128 | 11.5 | .06 | 1.35 | | 2.4 |
| 1.40 - 1.60 | 9.2 | 8.9 | 8,047 | 32.7 | .13 | 1.13 | | 89.7 | 97.3 | 10,812 | 13.6 | .06 | 1.32 | | 2.4 |
| Sink - 1.60 | 10.3 | 2.9 | 2,633 | 70.7 | 1.16 | 1.44 | | 100.0 | 100.0 | 9,967 | 19.5 | .18 | 1.34 | | 2.7 |
| Minus 100 mesh | 9.2 | 8.1 | 9,580 | 24.4 | .16 | 1.20 | | 100.0 | 100.0 | 9,935 | 19.9 | .18 | 1.32 | | 2.7 |
| TOP SIZE: 14 | | | | | | | | | | | | | | | |
| Size fraction: 14 x 0 | | | | | | | | | | | | | | | |
| Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 56.1 | 65.0 | 11,434 | 9.6 | 0.03 | 1.30 | 0.03 | 56.1 | 65.0 | 11,434 | 9.6 | 0.03 | 1.30 | 0.03 | 2.3 |
| 1.30 - 1.40 | 23.4 | 24.5 | 10,304 | 17.3 | .09 | 1.29 | .03 | 79.5 | 89.4 | 11,101 | 11.9 | .05 | 1.30 | .03 | 2.3 |
| 1.40 - 1.60 | 9.9 | 8.1 | 8,064 | 32.6 | .14 | 1.11 | .04 | 89.3 | 97.5 | 10,766 | 14.2 | .06 | 1.28 | .03 | 2.4 |
| Sink - 1.60 | 10.7 | 2.5 | 2,318 | 71.9 | .75 | .97 | .09 | 100.0 | 100.0 | 9,865 | 20.3 | .13 | 1.24 | .04 | 2.5 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

TABLE 14. - Detailed washability analyses of sample No. 9

STATE: Texas
COUNTY: Panola

FORMATION: Uncorrelated
GROUP: Wilcox

| Product | Direct: Recovery, pct. Weight | Direct: Recovery, pct. Btu | Direct: Btu/lb | Direct: Percent Ash | Direct: Percent Pyritic sulfur | Direct: Percent Total sulfur | Direct: $Na_2O$[1] | Cumulative: Recovery, pct. Weight | Cumulative: Recovery, pct. Btu | Cumulative: Btu/lb | Cumulative: Percent Ash | Cumulative: Percent Pyritic sulfur | Cumulative: Percent Total sulfur | Cumulative: $Na_2O$[1] | Pounds, $SO_2$/MM Btu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP SIZE: 1-1/2 | | | | | | | | | | | | | | | |
| Size fraction: 1-1/2 x 3/8 | | | | | | | | | | | | | | | |
| Weight percent: 79.3 | | | | | | | | | | | | | | | |
| Float- 1.30 | 97.0 | 97.5 | 11,334 | 6.9 | 0.09 | 1.30 | | 97.0 | 97.5 | 11,334 | 6.9 | 0.09 | 1.30 | | 2.3 |
| 1.30 - 1.40 | 2.5 | 2.1 | 9,829 | 20.3 | .86 | 2.90 | | 99.4 | 99.7 | 11,297 | 7.2 | .11 | 1.34 | | 2.4 |
| 1.40 - 1.60 | .4 | .3 | 8,974 | 26.2 | 1.82 | 2.78 | | 99.8 | 100.0 | 11,288 | 7.3 | .12 | 1.34 | | 2.4 |
| Sink - 1.60 | .2 | .0 | 2,216 | 77.8 | 2.63 | 2.97 | | 100.0 | 100.0 | 11,271 | 7.4 | .12 | 1.35 | | 2.4 |
| Size fraction: 3/8 x 14 | | | | | | | | | | | | | | | |
| Weight percent: 16.5 | | | | | | | | | | | | | | | |
| Float- 1.30 | 89.9 | 92.3 | 11,310 | 8.4 | 0.16 | 1.08 | | 89.9 | 92.3 | 11,310 | 8.4 | 0.16 | 1.08 | | 1.9 |
| 1.30 - 1.40 | 5.8 | 5.4 | 10,290 | 16.0 | .55 | 1.42 | | 95.7 | 97.7 | 11,248 | 8.9 | .18 | 1.10 | | 2.0 |
| 1.40 - 1.60 | 2.3 | 1.7 | 8,447 | 29.1 | 1.26 | 1.99 | | 98.0 | 99.5 | 11,184 | 9.3 | .21 | 1.12 | | 2.0 |
| Sink - 1.60 | 2.0 | .5 | 2,830 | 66.1 | 17.70 | 17.71 | | 100.0 | 100.0 | 11,014 | 10.5 | .56 | 1.46 | | 2.6 |
| Size fraction: 14 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 4.2 | | | | | | | | | | | | | | | |
| Float- 1.30 | 55.4 | 59.1 | 11,708 | 6.0 | 0.05 | 1.03 | | 55.4 | 59.1 | 11,708 | 6.0 | 0.05 | 1.03 | | 1.8 |
| 1.30 - 1.40 | 30.3 | 31.3 | 11,325 | 8.0 | .07 | .99 | | 85.7 | 90.4 | 11,573 | 6.7 | .06 | 1.02 | | 1.8 |
| 1.40 - 1.60 | 7.9 | 7.1 | 9,868 | 15.6 | .26 | 1.04 | | 93.6 | 97.5 | 11,428 | 7.5 | .07 | 1.02 | | 1.8 |
| Sink - 1.60 | 6.4 | 2.5 | 4,294 | 56.5 | 11.43 | 11.68 | | 100.0 | 100.0 | 10,975 | 10.6 | .80 | 1.70 | | 3.1 |
| Size composite: 1-1/2 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 94.1 | 95.8 | 11,339 | 7.1 | 0.10 | 1.26 | | 94.1 | 95.8 | 11,339 | 7.1 | 0.10 | 1.26 | | 2.2 |
| 1.30 - 1.40 | 4.2 | 11.7 | 10,388 | 15.6 | .55 | 1.98 | | 98.3 | 99.0 | 11,299 | 7.5 | .12 | 1.29 | | 2.3 |
| 1.40 - 1.60 | 1.0 | 3.1 | 9,073 | 23.8 | 1.09 | 1.91 | | 99.3 | 99.8 | 11,276 | 7.6 | .13 | 1.30 | | 2.3 |
| Sink - 1.60 | .7 | 1.1 | 3,226 | 65.0 | 12.47 | 12.63 | | 100.0 | 100.0 | 11,216 | 8.1 | .22 | 1.38 | | 2.5 |
| Minus 100 mesh | 1.2 | 1.0 | 9,856 | 20.1 | .49 | 1.51 | | 100.0 | 100.0 | 11,200 | 8.2 | .22 | 1.38 | | 2.5 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

TABLE 14. - Detailed washability analyses of sample No. 9 (Con.)

STATE: Texas
COUNTY: Panola

FORMATION: Uncorrelated
GROUP: Wilcox

| Product | Direct | | | | | | | Cumulative | | | | | | | Pounds, $SO_2$/MM Btu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Recovery, pct. | | | Percent | | | | Recovery, pct. | | | Percent | | | | |
| | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | |
| TOP SIZE: 3/8 | | | | | | | | | | | | | | | |
| Size fraction: 3/8 x 14<br>Weight percent: 68.5 | | | | | | | | | | | | | | | |
| Float- 1.30 | 92.2 | 93.6 | 11,448 | 6.9 | 0.07 | 1.09 | | 92.2 | 93.5 | 11,448 | 6.9 | 0.07 | 1.09 | | 1.9 |
| 1.30 - 1.40 | 4.9 | 4.6 | 10,383 | 16.0 | .31 | 1.16 | | 97.1 | 98.2 | 11,394 | 7.4 | .08 | 1.09 | | 1.9 |
| 1.40 - 1.60 | 2.0 | 1.6 | 8,986 | 25.8 | .72 | 1.46 | | 99.1 | 99.7 | 11,346 | 7.7 | .09 | 1.10 | | 1.9 |
| Sink - 1.60 | .9 | .3 | 3,184 | 64.9 | 19.20 | 19.20 | | 100.0 | 100.0 | 11,271 | 8.3 | .27 | 1.27 | | 2.2 |
| Size fraction: 14 x 100<br>Weight percent: 31.8 | | | | | | | | | | | | | | | |
| Float- 1.30 | 70.3 | 72.9 | 11,647 | 6.2 | 0.04 | 1.04 | | 70.3 | 72.9 | 11,647 | 6.2 | 0.04 | 1.04 | | 1.8 |
| 1.30 - 1.40 | 20.3 | 20.2 | 11,175 | 9.2 | .09 | .98 | | 90.6 | 93.2 | 11,541 | 6.9 | .05 | 1.03 | | 1.8 |
| 1.40 - 1.60 | 6.6 | 5.8 | 9,906 | 16.3 | .24 | .99 | | 97.2 | 99.0 | 11,430 | 7.5 | .06 | 1.02 | | 1.8 |
| Sink - 1.60 | 2.8 | 1.0 | 4,022 | 58.6 | 9.29 | 9.34 | | 100.0 | 100.0 | 11,219 | 9.0 | .33 | 1.26 | | 2.2 |
| Size composite: 3/8 x 100<br>Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 85.3 | 88.3 | 11,499 | 6.7 | 0.06 | 1.08 | | 85.3 | 88.3 | 11,499 | 6.7 | 0.06 | 1.08 | | 1.9 |
| 1.30 - 1.40 | 9.8 | 14.8 | 10,900 | 11.6 | .17 | 1.04 | | 95.0 | 96.7 | 11,438 | 7.2 | .07 | 1.07 | | 1.9 |
| 1.40 - 1.60 | 3.4 | 4.2 | 9,542 | 20.0 | .43 | 1.18 | | 98.5 | 99.5 | 11,371 | 7.7 | .09 | 1.08 | | 1.9 |
| Sink - 1.60 | 1.5 | .7 | 3,677 | 61.2 | 13.36 | 13.39 | | 100.0 | 100.0 | 11,255 | 8.5 | .29 | 1.26 | | 2.2 |
| Minus 100 mesh | 10.1 | 8.7 | 10,654 | 13.7 | .29 | 1.77 | | 100.0 | 100.0 | 11,199 | 9.0 | .29 | 1.31 | | 2.3 |
| TOP SIZE: 14 | | | | | | | | | | | | | | | |
| Size fraction: 14 x 0<br>Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 77.0 | 78.7 | 11,449 | 6.5 | 0.06 | 1.03 | 0.07 | 77.0 | 78.7 | 11,449 | 6.5 | 0.06 | 1.03 | 0.07 | 1.8 |
| 1.30 - 1.40 | 19.6 | 19.3 | 11,051 | 10.6 | .12 | 1.19 | .10 | 96.6 | 98.0 | 11,368 | 7.3 | .07 | 1.06 | .08 | 1.9 |
| 1.40 - 1.60 | 2.0 | 1.6 | 9,264 | 23.5 | .49 | 1.07 | .08 | 98.5 | 99.6 | 11,326 | 7.7 | .08 | 1.06 | .08 | 1.9 |
| Sink - 1.60 | 1.5 | .4 | 2,829 | 68.6 | 13.73 | 14.93 | .06 | 100.0 | 100.0 | 11,202 | 8.5 | .28 | 1.27 | .08 | 2.3 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

inch top size and removing the sink 1.30 specific gravity material would provide a product analyzing 6.7 percent ash at a Btu recovery of 88.3 percent. The ash reduction would be 26 percent. None of this coal is washed.

Channel sample No. 10 was collected from an uncorrelated formation, Wilcox Group, in Titus County, Texas. A section of the bed is described as follows:

Bed Section[1]

| | Feet | Inches |
|---|---|---|
| Lignite | 1 | 0 |
| Carbonaceous shale | | 6 |
| Lignite | 1 | 4 |
| Carbonaceous shale | | 3 |
| Lignite | 1 | 11 |
| Total thickness of bed and sample | 7 | 0 |

[1]Overlying bed: shale; floor: fireclay.

Table 15 shows the detailed washability analyses of sample No. 10. The composite washability sample contained an average of 10,122 Btu/lb, 17.0 percent ash, 0.10 percent pyritic sulfur, and 0.83 percent total sulfur. The sodium oxide content in the coal was 0.09 percent. This sample contained an average of 0.73 percent organic sulfur and could not be upgraded to meet the current $SO_2$ emission standard. Crushing to 3/8 inch top size and removing the sink 1.40 specific gravity material would provide a product analyzing 12.2 percent ash, at a Btu recovery of 91.8 percent. The ash reduction would be 29 percent. None of this coal is washed.

Channel sample No. 11 was collected from a Yegua formation, Clairborne Group, in Angelina County, Texas. A section of the bed is described as follows:

Bed Section[1]

| | Feet | Inches |
|---|---|---|
| Lignite | 4 | 0 |
| Total thickness of bed and sample | 4 | 0 |

[1]Overlying bed: shale; floor: sandstone.

Table 16 shows the detailed washability analyses of sample No. 11. The composite washability sample contained an average of 10,590 Btu/lb,

TABLE 15. - Detailed washability analyses of sample No. 10

STATE: Texas
COUNTY: Titus

FORMATION: Uncorrelated
GROUP: Wilcox

| Product | Direct | | | | | | | Cumulative | | | | | | | Pounds, $SO_2$/MM Btu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Recovery, pct. | | | Percent | | | | Recovery, pct. | | | Percent | | | | |
| | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | |
| TOP SIZE: 1-1/2 | | | | | | | | | | | | | | | |
| Size fraction: 1-1/2 x 3/8 | | | | | | | | | | | | | | | |
| Weight percent: 78.9 | | | | | | | | | | | | | | | |
| Float- 1.30 | 80.0 | 84.0 | 10,686 | 12.7 | 0.07 | 0.84 | | 80.0 | 84.0 | 10,686 | 12.7 | 0.07 | 0.84 | | 1.6 |
| 1.30 - 1.40 | 12.2 | 11.4 | 9,468 | 22.9 | .13 | .84 | | 92.2 | 95.4 | 10,524 | 14.1 | .08 | .84 | | 1.6 |
| 1.40 - 1.60 | 5.0 | 3.6 | 7,469 | 37.7 | .48 | 1.05 | | 97.2 | 99.1 | 10,369 | 15.3 | .10 | .85 | | 1.6 |
| Sink - 1.60 | 2.8 | .9 | 3,398 | 66.6 | .24 | .55 | | 100.0 | 100.0 | 10,172 | 16.7 | .10 | .84 | | 1.7 |
| Size fraction: 3/8 x 14 | | | | | | | | | | | | | | | |
| Weight percent: 17.5 | | | | | | | | | | | | | | | |
| Float- 1.30 | 70.4 | 76.8 | 10,759 | 11.7 | 0.03 | 0.85 | | 70.4 | 76.8 | 10,759 | 11.7 | 0.03 | 0.85 | | 1.6 |
| 1.30 - 1.40 | 16.3 | 15.8 | 9,567 | 20.8 | .13 | .86 | | 86.7 | 92.6 | 10,536 | 13.4 | .05 | .85 | | 1.6 |
| 1.40 - 1.60 | 7.3 | 5.6 | 7,499 | 36.4 | .48 | 1.13 | | 94.0 | 98.1 | 10,298 | 15.2 | .08 | .87 | | 1.7 |
| Sink - 1.60 | 6.0 | 1.9 | 3,079 | 69.9 | .94 | 1.14 | | 100.0 | 100.0 | 9,868 | 18.5 | .13 | .89 | | 1.8 |
| Size fraction: 14 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 3.6 | | | | | | | | | | | | | | | |
| Float- 1.30 | 28.0 | 33.0 | 11,273 | 9.3 | 0.02 | 0.85 | | 28.0 | 33.0 | 11,273 | 9.3 | 0.02 | 0.85 | | 1.5 |
| 1.30 - 1.40 | 38.0 | 42.3 | 10,669 | 12.2 | .04 | .80 | | 65.9 | 75.3 | 10,925 | 11.0 | .03 | .82 | | 1.5 |
| 1.40 - 1.60 | 20.1 | 19.1 | 9,067 | 22.9 | .17 | .82 | | 86.0 | 94.4 | 10,491 | 13.8 | .06 | .82 | | 1.6 |
| Sink - 1.60 | 14.0 | 5.6 | 3,839 | 63.5 | 1.77 | 2.16 | | 100.0 | 100.0 | 9,562 | 20.7 | .30 | 1.01 | | 2.1 |
| Size composite: 1-1/2 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 76.4 | 82.2 | 10,705 | 12.5 | 0.06 | 0.84 | | 76.4 | 82.2 | 10,705 | 12.5 | 0.06 | 0.84 | | 1.6 |
| 1.30 - 1.40 | 13.9 | 15.3 | 9,607 | 21.4 | .12 | .84 | | 90.3 | 94.4 | 10,536 | 13.9 | .07 | .84 | | 1.6 |
| 1.40 - 1.60 | 5.9 | 6.0 | 7,671 | 35.6 | .44 | 1.04 | | 96.2 | 98.8 | 10,360 | 15.2 | .09 | .85 | | 1.6 |
| Sink - 1.60 | 3.8 | 1.8 | 3,368 | 67.1 | .64 | .93 | | 100.0 | 100.0 | 10,096 | 17.2 | .12 | .86 | | 1.7 |
| Minus 100 mesh | .9 | .7 | 7,775 | 36.1 | .27 | .88 | | 100.0 | 100.0 | 10,076 | 17.3 | .12 | .86 | | 1.7 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

TABLE 15. - Detailed washability analyses of sample No. 10 (Con.)

STATE: Texas
COUNTY: Titus

FORMATION: Uncorrelated
GROUP: Wilcox

| Product | Direct | | | | | | | Cumulative | | | | | | | Pounds, $SO_2$/MM Btu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Recovery, pct. | | | Percent | | | | Recovery, pct. | | | Percent | | | | |
| | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | |
| TOP SIZE: 3/8 | | | | | | | | | | | | | | | |
| Size fraction: 3/8 x 14<br>Weight percent: 66.7 | | | | | | | | | | | | | | | |
| Float- 1.30 | 75.0 | 80.1 | 10,850 | 11.3 | 0.00 | 0.80 | | 75.0 | 80.1 | 10,850 | 11.3 | 0.00 | 0.80 | | 1.5 |
| 1.30 - 1.40 | 14.2 | 13.5 | 9,684 | 20.1 | .06 | .75 | | 89.2 | 93.6 | 10,665 | 12.7 | .01 | .79 | | 1.5 |
| 1.40 - 1.60 | 6.6 | 5.0 | 7,766 | 34.4 | .66 | .82 | | 95.8 | 98.7 | 10,465 | 14.2 | .05 | .79 | | 1.5 |
| Sink - 1.60 | 4.2 | 1.3 | 3,227 | 67.8 | .25 | .98 | | 100.0 | 100.0 | 10,162 | 16.4 | .06 | .80 | | 1.6 |
| Size fraction: 14 x 100<br>Weight percent: 33.3 | | | | | | | | | | | | | | | |
| Float- 1.30 | 52.7 | 58.0 | 11,332 | 9.6 | 0.14 | 0.85 | | 52.7 | 58.0 | 11,332 | 9.6 | 0.14 | 0.85 | | 1.5 |
| 1.30 - 1.40 | 29.6 | 30.1 | 10,462 | 14.3 | .29 | .85 | | 82.4 | 88.1 | 11,019 | 11.3 | .19 | .85 | | 1.5 |
| 1.40 - 1.60 | 11.6 | 9.6 | 8,497 | 27.1 | .10 | .78 | | 94.0 | 97.7 | 10,708 | 13.2 | .18 | .84 | | 1.6 |
| Sink - 1.60 | 6.0 | 2.3 | 3,927 | 63.4 | 1.30 | 1.64 | | 100.0 | 100.0 | 10,298 | 16.3 | .25 | .89 | | 1.7 |
| Size composite: 3/8 x 100<br>Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 67.6 | 74.4 | 10,975 | 10.9 | 0.04 | 0.81 | | 67.6 | 74.4 | 10,975 | 10.9 | 0.04 | 0.81 | | 1.5 |
| 1.30 - 1.40 | 19.3 | 22.0 | 10,081 | 17.1 | .18 | .80 | | 86.9 | 91.9 | 10,776 | 12.3 | .07 | .81 | | 1.5 |
| 1.40 - 1.60 | 8.3 | 7.2 | 8,107 | 31.0 | .40 | .80 | | 95.2 | 98.3 | 10,544 | 13.9 | .10 | .81 | | 1.5 |
| Sink - 1.60 | 4.8 | 1.7 | 3,519 | 66.0 | .69 | 1.26 | | 100.0 | 100.0 | 10,207 | 16.4 | .12 | .83 | | 1.6 |
| Minus 100 mesh | 8.7 | 7.0 | 8,872 | 27.7 | .08 | .81 | | 100.0 | 100.0 | 10,100 | 17.3 | .12 | .83 | | 1.6 |
| TOP SIZE: 14 | | | | | | | | | | | | | | | |
| Size fraction: 14 x 0<br>Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 55.2 | 60.3 | 11,116 | 9.8 | 0.01 | 0.81 | 0.09 | 55.2 | 60.3 | 11,116 | 9.8 | 0.01 | 0.81 | 0.09 | 1.5 |
| 1.30 - 1.40 | 27.1 | 27.2 | 10,242 | 16.2 | .02 | .74 | .09 | 82.3 | 87.5 | 10,829 | 11.9 | .01 | .79 | .09 | 1.5 |
| 1.40 - 1.60 | 13.7 | 11.3 | 8,404 | 28.0 | .05 | .67 | .08 | 96.1 | 98.8 | 10,482 | 14.2 | .02 | .77 | .09 | 1.5 |
| Sink - 1.60 | 3.9 | 1.2 | 3,124 | 69.2 | 1.12 | 1.42 | .12 | 100.0 | 100.0 | 10,191 | 16.4 | .06 | .80 | .09 | 1.6 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

TABLE 16. - Detailed washability analyses of sample No. 11

STATE: Texas
COUNTY: Angelina

FORMATION: Yegua
GROUP: Clairborne

| Product | Direct | | | | | | | Cumulative | | | | | | | Pounds, $SO_2$/MM Btu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Recovery, pct. | | | Percent | | | | Recovery, pct. | | | Percent | | | | |
| | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | |
| TOP SIZE: 1-1/2 | | | | | | | | | | | | | | | |
| Size fraction: 1-1/2 x 3/8 | | | | | | | | | | | | | | | |
| Weight percent: 80.8 | | | | | | | | | | | | | | | |
| Float- 1.30 | 92.2 | 94.4 | 11,073 | 10.9 | 0.04 | 1.20 | | 92.2 | 94.4 | 11,073 | 10.9 | 0.04 | 1.20 | | 2.2 |
| 1.30 - 1.40 | 5.6 | 4.9 | 9,468 | 21.9 | .09 | 1.29 | | 97.8 | 99.3 | 10,982 | 11.5 | .04 | 1.21 | | 2.2 |
| 1.40 - 1.60 | .6 | .3 | 5,436 | 51.4 | .36 | 1.03 | | 98.4 | 99.6 | 10,949 | 11.8 | .04 | 1.20 | | 2.2 |
| Sink - 1.60 | 1.6 | .4 | 2,780 | 72.6 | 2.10 | 2.16 | | 100.0 | 100.0 | 10,818 | 12.7 | .08 | 1.22 | | 2.3 |
| Size fraction: 3/8 x 14 | | | | | | | | | | | | | | | |
| Weight percent: 14.9 | | | | | | | | | | | | | | | |
| Float- 1.30 | 80.0 | 87.8 | 10,852 | 12.2 | 0.04 | 1.27 | | 80.0 | 87.8 | 10,852 | 12.2 | 0.04 | 1.27 | | 2.3 |
| 1.30 - 1.40 | 9.1 | 8.0 | 8,610 | 27.8 | .11 | 1.42 | | 89.1 | 95.8 | 10,622 | 13.8 | .05 | 1.29 | | 2.4 |
| 1.40 - 1.60 | 5.1 | 3.1 | 5,873 | 46.8 | .14 | 1.07 | | 94.2 | 98.8 | 10,363 | 15.6 | .05 | 1.27 | | 2.5 |
| Sink - 1.60 | 5.8 | 1.2 | 2,019 | 75.8 | .78 | 1.07 | | 100.0 | 100.0 | 9,882 | 19.1 | .09 | 1.26 | | 2.6 |
| Size fraction: 14 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 4.3 | | | | | | | | | | | | | | | |
| Float- 1.30 | 50.0 | 64.9 | 11,187 | 10.3 | 0.04 | 1.23 | | 50.9 | 64.9 | 11,187 | 10.3 | 0.04 | 1.23 | | 2.2 |
| 1.30 - 1.40 | 16.4 | 17.8 | 9,385 | 20.7 | .07 | 1.47 | | 66.4 | 82.8 | 10,742 | 12.9 | .05 | 1.29 | | 2.4 |
| 1.40 - 1.60 | 13.1 | 10.6 | 6,985 | 36.5 | .10 | 1.14 | | 79.5 | 93.4 | 10,122 | 16.8 | .06 | 1.26 | | 2.5 |
| Sink - 1.60 | 20.5 | 6.6 | 2,780 | 69.6 | .36 | .99 | | 100.0 | 100.0 | 8,618 | 27.6 | .12 | 1.21 | | 2.8 |
| Size composite: 1-1/2 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 88.6 | 92.8 | 11,046 | 11.1 | 0.04 | 1.21 | | 88.6 | 92.8 | 11,046 | 11.1 | 0.04 | 1.21 | | 2.2 |
| 1.30 - 1.40 | 6.6 | 6.9 | 9,281 | 23.0 | .09 | 1.34 | | 95.2 | 98.3 | 10,924 | 11.9 | .04 | 1.22 | | 2.2 |
| 1.40 - 1.60 | 1.8 | 4.7 | 6,105 | 44.8 | .19 | 1.08 | | 97.0 | 99.3 | 10,834 | 12.5 | .05 | 1.22 | | 2.2 |
| Sink - 1.60 | 3.0 | 2.4 | 2,564 | 72.6 | 1.22 | 1.51 | | 100.0 | 100.0 | 10,583 | 14.3 | .08 | 1.23 | | 2.3 |
| Minus 100 mesh | 1.1 | .9 | 8,161 | 35.7 | .26 | 1.31 | | 100.0 | 100.0 | 10,556 | 14.6 | .08 | 1.23 | | 2.3 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

TABLE 16. - Detailed washability analyses of sample No. 11 (Con.)

STATE: Texas
COUNTY: Angelina

FORMATION: Yegua
GROUP: Clairborne

| Product | Direct | | | | | | | Cumulative | | | | | | | Pounds, $SO_2$/MM Btu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Recovery, pct. | | | Percent | | | | Recovery, pct. | | | Percent | | | | |
| | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | Weight | Btu | Btu/lb | Ash | Pyritic sulfur | Total sulfur | $Na_2O$[1] | |
| TOP SIZE: 3/8 | | | | | | | | | | | | | | | |
| Size fraction: 3/8 x 14 | | | | | | | | | | | | | | | |
| Weight percent: 73.6 | | | | | | | | | | | | | | | |
| Float- 1.30 | 92.7 | 95.7 | 11,195 | 10.0 | 0.06 | 1.33 | | 92.7 | 95.7 | 11,195 | 10.0 | 0.06 | 1.33 | | 2.4 |
| 1.30 - 1.40 | 3.8 | 3.1 | 8,707 | 28.4 | .14 | 1.26 | | 96.5 | 98.8 | 11,097 | 10.7 | .06 | 1.33 | | 2.4 |
| 1.40 - 1.60 | 1.5 | .8 | 5,871 | 46.6 | .18 | 1.02 | | 98.0 | 99.6 | 11,016 | 11.3 | .06 | 1.32 | | 2.4 |
| Sink - 1.60 | 2.0 | .4 | 2,141 | 75.3 | 1.44 | 1.66 | | 100.0 | 100.0 | 10,838 | 12.6 | .09 | 1.33 | | 2.5 |
| Size fraction: 14 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 26.4 | | | | | | | | | | | | | | | |
| Float- 1.30 | 80.8 | 87.6 | 11,480 | 9.4 | 0.04 | 1.21 | | 80.8 | 87.6 | 11,480 | 9.4 | 0.04 | 1.21 | | 2.1 |
| 1.30 - 1.40 | 4.8 | 4.6 | 10,041 | 17.2 | .07 | 1.32 | | 85.6 | 92.1 | 11,399 | 9.8 | .04 | 1.22 | | 2.1 |
| 1.40 - 1.60 | 6.8 | 5.4 | 8,401 | 26.7 | .11 | 1.24 | | 92.4 | 97.5 | 11,177 | 11.1 | .05 | 1.22 | | 2.2 |
| Sink - 1.60 | 7.6 | 2.5 | 3,423 | 64.4 | .42 | 1.11 | | 100.0 | 100.0 | 10,589 | 15.1 | .08 | 1.21 | | 2.3 |
| Size composite: 3/8 x 100 | | | | | | | | | | | | | | | |
| Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 89.5 | 93.8 | 11,262 | 9.9 | 0.06 | 1.30 | | 89.5 | 93.8 | 11,262 | 9.9 | 0.06 | 1.30 | | 2.3 |
| 1.30 - 1.40 | 4.1 | 3.5 | 9,121 | 24.9 | .10 | 1.28 | | 93.6 | 97.2 | 11,169 | 10.5 | .06 | 1.30 | | 2.3 |
| 1.40 - 1.60 | 2.9 | 3.7 | 7,432 | 34.3 | .14 | 1.16 | | 96.5 | 99.1 | 11,056 | 11.2 | .06 | 1.30 | | 2.3 |
| Sink - 1.60 | 3.5 | 1.6 | 2,879 | 69.0 | .85 | 1.34 | | 100.0 | 100.0 | 10,772 | 13.2 | .09 | 1.30 | | 2.4 |
| Minus 100 mesh | 6.2 | 5.0 | 9,092 | 25.5 | .12 | 1.20 | | 100.0 | 100.0 | 10,674 | 14.0 | .09 | 1.29 | | 2.4 |
| TOP SIZE: 14 | | | | | | | | | | | | | | | |
| Size fraction: 14 x 0 | | | | | | | | | | | | | | | |
| Weight percent: 100.0 | | | | | | | | | | | | | | | |
| Float- 1.30 | 85.5 | 91.2 | 11,239 | 10.0 | 0.05 | 1.29 | 0.25 | 85.5 | 91.2 | 11,239 | 10.0 | 0.05 | 1.29 | 0.25 | 2.3 |
| 1.30 - 1.40 | 7.0 | 6.2 | 9,263 | 23.6 | .12 | 1.27 | .30 | 92.5 | 97.3 | 11,089 | 11.0 | .06 | 1.29 | .25 | 2.3 |
| 1.40 - 1.60 | 3.7 | 2.1 | 6,040 | 46.4 | .12 | .83 | .38 | 96.2 | 99.4 | 10,895 | 12.4 | .06 | 1.27 | .25 | 2.3 |
| Sink - 1.60 | 3.8 | .6 | 1,536 | 81.5 | .83 | 1.04 | .58 | 100.0 | 100.0 | 10,540 | 15.0 | .09 | 1.26 | .27 | 2.4 |

[1]Sodium oxide performed only on 14 mesh x 0 sample.

14.5 percent ash, 0.09 percent pyritic sulfur, and 1.26 percent total sulfur. The sodium oxide content in the coal was 0.27 percent. This coal contained an average of 1.17 percent organic sulfur and could not be upgraded to meet the current $SO_2$ emission standard. Crushing to 14 mesh top size and removing the sink 1.30 specific gravity material would provide a product containing 10.0 percent ash at a Btu recovery of 91.2 percent. The ash reduction would be 33 percent. This is a new mine undergoing a feasibility study.

## Sodium Reduction

Table 17 summarizes the results of laboratory ion exchange tests with Arkansas and Texas lignites. In these tests, products having lower sodium oxide in the ash were consistently obtained by treating these lignites with a solution containing calcium ions. Because the quantity of exchange ions, particle size distribution and reaction time were constant; the maximum amount of sodium that might be removed from each sample was not determined. The sodium oxide reductions for the coals tested ranged from 37 to 91 percent.

TABLE 17. - Ion exchange test results with minus 14 mesh Arkansas and Texas lignites

| Sample No. | Raw coal Analysis, percent Ash | Raw coal Analysis, percent $Na_2O$ in ash Untreated | Raw coal Analysis, percent $Na_2O$ in ash Treated | Float 1.60 specific gravity product Recovery, percent Btu's | Float 1.60 specific gravity product Analysis, percent Ash | Float 1.60 specific gravity product Analysis, percent $Na_2O$ in ash Untreated | Float 1.60 specific gravity product Analysis, percent $Na_2O$ in ash Treated |
|---|---|---|---|---|---|---|---|
| | | | Arkansas lignite | | | | |
| 1 | 11.3 | 0.19 | 0.11 | 99.5 | 9.9 | 0.24 | 0.09 |
| 2 | 17.0 | .19 | .12 | 99.6 | 14.7 | .27 | .12 |
| 3 | 15.0 | .08 | .04 | 98.2 | 11.8 | .08 | .05 |
| 4 | 43.4 | .27 | .17 | 88.3 | 31.9 | .39 | .14 |
| | | | Texas lignite | | | | |
| 5 | 10.2 | 0.98 | 0.22 | 97.8 | 9.0 | 0.91 | 0.25 |
| 6 | 13.5 | .67 | .14 | 98.8 | 11.4 | .54 | .14 |
| 7 | 8.8 | 1.13 | .37 | 99.9 | 8.5 | 1.09 | .35 |
| 8 | 20.3 | .24 | .14 | 97.5 | 14.2 | .30 | .12 |
| 9 | 8.5 | 1.06 | .31 | 99.6 | 7.7 | 1.08 | .25 |
| 10 | 16.4 | .65 | .19 | 98.8 | 14.2 | .73 | .23 |
| 11 | 15.0 | 1.27 | .12 | 99.4 | 12.4 | 1.05 | .12 |

## DISCUSSION OF RESULTS

The washability data given in tables 6-9 for the lignite samples collected in Arkansas show that, of the four samples, only samples 1 and 2, from Dallas County, could be upgraded to meet the current EPA $SO_2$ emission standard of 1.2 pounds $SO_2$/MM Btu. Sample No. 1 contained an average of 0.47 percent pyritic sulfur and 0.46 percent organic sulfur. As shown in table 6, it could be upgraded to comply with the EPA emission standard by crushing to 3/8-inch top size and removing the sink 1.30 specific gravity material. Sample No. 2 contained, on the average, 0.05 percent pyritic sulfur and only 0.65 percent organic sulfur. It could be upgraded to meet the standard by crushing to 1-1/2-inch top size and removing the sink 1.30 specific gravity material as shown in table 7.

The washability data for the Texas lignites (tables 10-16) show that none of these samples could be upgraded to meet the EPA standard regardless of the degree of crushing or specific gravity of separation due to the organic sulfur content which ranged from 0.7 to 1.3 percent.

Although physical cleaning generally provided inadequate desulfurization with all but the two Arkansas lignite samples from Dallas County, it did provide significant ash reduction. And as pointed out earlier, boiler fouling increases exponentially with the ash content of a coal for all levels of sodium oxide in the ash. Crushing and gravimetric separation, therefore, may contribute significantly to a reduction in boiler fouling.

The weight-percent yields obtained at the 1.30 specific gravity of separation for the material crushed to 1-1/2 inches top size were high, except for one sample which yielded 42.8 percent. The other 10 samples ranged from 75.9 percent to 96.7 percent yield. This high yield of float 1.30 material is attributable to the low specific gravity of lignite. It is reported that the specific gravity of lignite containing 36 percent moisture is 1.28 and decreases to 1.22 as the moisture decreases to zero (10).

Size analysis of the Arkansas and Texas lignite samples showed that all samples remained relatively coarse after crushing to 1-1/2 inches top size with none containing less than 73 percent of 1-1/2 by 3/8 inch material. The size distribution coefficient $n$ ranged from 0.7 to 0.8 which is within the normal range for most higher rank coals.

All of these Arkansas and Texas lignite samples were noncoking with free swelling indices of 0. The ash softening temperatures ranged from 2,140 to 2,910° F. Generally, the Btu per pound (moisture free basis) for the raw lignite samples was around 10,000 to 11,500 with the ash contents ranging from 9.3 to 19.3 percent. One of the Arkansas samples, however, contained 43.1 percent ash and 6,672 Btu/lb.

The sodium oxide in the lignites analyzed 0.27 percent or less and thus should not cause much boiler fouling. This low sodium content appears to be typical of Arkansas and Texas lignites. Although boiler fouling caused by the presence of sodium should not be a problem, it is interesting to note that treatment of these lignite samples with calcium ions provided sodium oxide reductions ranging from 37 to 91 percent. The significance of these ion exchange tests is to demonstrate that treatment of lignite with a solution containing calcium ions will reduce its sodium content.

## CONCLUSIONS

1. Only the two Arkansas samples collected from Dallas County could be upgraded to meet the new source performance standard of 1.2 pounds of $SO_2$/MM Btu.

2. None of the samples collected from Texas could be upgraded to meet the EPA standard.

3. Even though the samples collected from Arkansas and Texas averaged only 1.1 percent total sulfur, approximately 80 percent of this was organic sulfur; thus, 9 of the 11 samples could not be physically upgraded to meet EPA's new source performance standard.

4. The size analyses of the Arkansas and Texas lignite samples showed nonfriability with all samples containing more than 73 percent of plus 3/8 inch material after crushing to 1-1/2 inches top size.

5. Except for one sample, crushing and gravimetric separation would provide minimal sulfur reduction but would provide significant ash reduction and increased calorific value.

6. The sodium oxide in the coals analyzed 0.27 percent or less and thus should not cause much boiler fouling. However, since the ash fouling rate is related to the quantity of ash as well as the sodium content, physical coal cleaning to remove ash should reduce boiler fouling.

7. Treatment of these lignite samples with calcium ions would provide sodium oxide reductions ranging from 37 to 91 percent.

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